CHAPTER-II

REVIEW OF RELATED LITERATURE

A literature review surveys books, scholarly articles, and any other sources relevant to a particular issue, area of research, or theory, and by so doing, provides a description, summary, and critical evaluation of these works in relation to the research problem being investigated. Literature reviews are designed to provide an overview of sources you have explored while researching a particular topic and to demonstrate to your readers how your research fits within a larger field of study **(Fink, 2014)**. Hence the literature review is the summery and critical analysis of pre availed research studies, which closely associated with the current problem.

A half century of field hockey research was reviewed via internet as a result 208 studies were found, which were published within the last 50 years (from 1960 to 2010). Field hockey had the status as an Olympic sport and popular over the world, even though the number of scientific studies which focused and published on field hockey was smaller amount when compared to other team sports, such as soccer, basketball, or baseball. The result of the study was found that most of publications (61.06%) come from five English-speaking countries (UK, USA, Canada, Australia, and New Zealand), with the mainstream on sport psychology, injuries and biochemistry. Anything revealed was that the vast majority of scientific studies used field hockey merely as a reference point in comparison to other team sports. The varying topic diversity of the scientific studies found among the databases significantly hinders an effective comparison of findings, especially considering that most of the studies focused on only a few selected aspects of the problem matter and were chiefly small sample studies, nor were they repeated **(Podgórski** and **Pawlak,**

2011). Hence, the researcher reviewed available literatures related to this study and described below for strengthening and get right direction to this research.

2.1 STUDIES ON FIELD HOCKEY

2.1.1 Analysis of Field Hockey

Field hockey is one of the international and spectator game, to analyze the game during international match via GPS showed the relative competition demands of the game in relation to physical and physiological aspects. In this connection 16 elite male field hockey players (age=25 ± 4 years, BM=70.9 ± 6.6 kg and VO2max=61.0 ± 2.1) Seventy-five elite level competition and 37 training analyses from 8 games and 4 training sessions were obtained. The duration of training was more than competition and covered a greater total distance (109 ± 2.5 vs. 74 ± 0.3 minutes and 7318 ± 221 vs. 5868 ± 75 m; $p < 0.001$ in both). There was no change in the high intensity sprinting and running distance during training and competition (114 ± 6 vs. 116 ± 9 m when sprinting and 457 ± 6 vs. 448 ± 7 m for high intensity running). The players were performed more high-intensity accelerations (37 ± 3 vs. 20 ± 2) during training compared to competition **(White and MacFarlane, 2015)**. The data of above study was lesser than the previous study was conducted by **Lythe and Kilding, 2011**. They found that the physical outputs of 18 elite male field hockey players (age: 24.4±4.5 yrs) were quantified during 5 matches using GPS units and heart rate monitors. An individual player covered maximum distance was 6 798±2 009 m and distance per position for 70 min ($position_{70}$) was 8 160±428 m. it was (p70) decreased between the 1^{st} and 2^{nd}halves (by 4.8% $P<0.05$). Fullbacks showed less total distance than all other positions ($P<0.05$). High-intensity running (>19 $km.h^{-1}$) comprised 6.1% (479±108 m) of the total distance covered and involved 34±12 sprints per player, with an average duration of 3.3 s. Average HR was higher in the 1^{st} half

(86.7% HR_{max}) than the 2nd half, (84.4% HR_{max}), though this was not significant (P=0.06). The result of the first study indicate the players having lower predicted aerobic capacity and covering less distance in competition than in some previous studies, these data support the suggestion that it is high-intensity activity that differentiates international level competition and further suggests that international players can replicate the intensity of competition during small sided games.

The above said statements were conducted while hockey has 2 halves; the game progressively evolved its dimension 2 x 35-minute halves to 4 x 15-minute quarters. The intention was to create a higher intensity, faster paced and more exciting game. The physical challenges presented by the new game structure are largely unknown. To find the necessity of this current situation **Morris et al., (2019)** conducted a study on performance across quarters in an international field hockey tournament. This study examined the presence and extent of performance decrements across quarters in matches during an international women's field hockey tournament. To achieve the purpose 20 international, female field hockey players (mean ± SD: age 23.0 ± 2.9 y, body mass 59.9 ± 4.9 kg, height 161.5 ±4.8 cm) 7 matches from one international tournament were analyzed. Based on GPS data, the locomotor functions were classified into three bands matching to low (0.00 - 1.68 m s^{-1}), moderate (1.69 m s^{-1} - 4.18 m s^{-1}), and high (4.19 m s^{-1}- > 5.27 m s^{-1}) speed running. Data were analyzed using a two-level repeated measures multi-level model, with match number at level 1 and player at level 2. Model fit was assessed using the -2*loglikelihood statistic. The total distances covered by players in a match in respect to quarters were 1778±258m, 1620±229m, 1613±225m and 1501±255m. The averages for high speed running distance were 376±181m, 297±146m, 310±135m and 276±125m respectively. When controlling for position, the decrement in high-speed distance covered in quarter 2, 3 and 4 compared with quarter 1 was -78, -64 and -98 m respectively (all $P<0.05$ compared with quarter 1). The result of the study showed that players cover their maximum total distance and high-speed distance during quarter 1, but are unable to maintain this performance level in the remaining quarters of a match during an international hockey tournament. In the mean while the current study revealed that the present form of field hockey has more intermittent nature, this statement closely associate (The HRpeak of the players was 198 ± 4 b·min-1 with a mean exercise intensity of 95 ± 1 % HRmax.) with **McGuinness et al., (2018)**.

2.1.2 Physiology of Field Hockey

Kusnanik et al., (2017) conducted a study on physiological demands of playing field hockey game at sub elite players. To achieve the purpose 9 female players (2 backs, 3 halves, 4 forwards) participated. The data collected from the variables were heart rate (HR), blood lactate (BL), distance covered and time spent on walking/running. Result showed that the HR and BL of players during warm-up, end of first half, starting of second half, and end of second half were 96.4±12.7 bpm and 1.7±0.8 mmol.L-1, 171.2±6.3 bpm and 5.2±3.1 mmol.L-1, 130.8±3.8 bpm and 3.7±3.6 mmol.L-1 and 157.4±12.7 bpm and 5.8±0.2 mmol±L-1 respectively. Total distance covered per player was 4372.5±263.9 m and mean time spent walking and running per player were 41.42 minutes and 28.18 minutes respectively. Finally, the study was concluded that the female field hockey players have lower heart rate, blood lactate concentration, distance covered and time spent walking/running than other players in the literature reviews.

Leslie (2012) examined the physiological and match performance characteristics of field hockey players in relation to age, sex and playing standard. The relationship between the physiological and match performance characteristics of players was also investigated. In this study the physiological characteristics of 159 elite male international U16, U18, U21 and senior (mean±*S.E*. age, 15±*0.1*; 16.9±*0.2*; 20.1±*0.2* and 24.9±*0.7* years respectively) players were assessed. Two kinds of test were administered, 77 players completed a series of lab tests including: treadmill VO2peak, repeated 10 x 6 s cycle ergometer sprints, maximum blood lactate concentration and running economy during submaximal treadmill running and 82 players completed a 15 m sprint and a multi-stage fitness test. There was no changes in VO2peak when squads were compared (U16 *vs*. U18 *vs*. U21 *vs*. senior; 58.7±*0.9* *vs*. 60.5±*0.8* *vs*. 60.9±*0.9* *vs*. 59.7±*0.9*; ml.kg-1.min-1; *P*>0.05). Successful U21 players were faster than unsuccessful U21 players over 15 m sprint (successful U21 *vs*. unsuccessful U21; 2.37±*0.02* *vs*. 2.44±*0.02*s; *P*<0.05). Next, non-differential GPS device used to assess the match performance characteristics (Duration, distance covered, mean speed and maximum speed were obtained for the total match and the 1st and 2nd halves) of elite level players. Results showed players from all age groups covered similar total distances (5385.0±*315.7*; 6608.4±*317.9*; 6260.4±*296.2*, m, U16 *vs*. U18. *vs*. senior, *P*>0.05) at similar mean speeds (8.0±*0.2* *vs*. 8.1±*0.3* *vs*. 7.6±*0.1*, km.h-1, U16 *vs*. U18. *vs*. senior, *P*>0.05) and the majority of the movements completed by players could be categorized as low-moderate intensity (<14.5 km.h-1) during match play (87.6 %, 86.7 % and 87.8 % for U16, U18 and senior players respectively). All age groups demonstrated fatigue during the second half of a match, but senior players exhibited the highest decrement in high intensity activity (>14.5 km.h-1). These result showed that 60 ml/kg/min VO2peak is a prerequisite for elite male hockey players from U16 level onwards and speed may be a key factor determining progression from junior to senior international level. The same study was adapted to elite female players. Amongst female players there were no differences between age groups in the distance covered (4962.3±*295.1* *vs*. 5202.5±*155.5* *vs*. 5581.1±*208.8* m, U16 *vs*. U18 *vs*. senior, *P*>0.05) the mean speed (23.3±0.6 vs. 23.5±0.7 vs. 24.3±0.3 km.h-1, U16 *vs*. U18 *vs*. senior, *P*>0.05) during a match. While senior females completed more high intensity movement (>14.5 km.h-1) than U16 players (5.0±*0.8* *vs*. 7.5±*0.6* %, *P*<0.05), there were no other differences in the match activity profiles between age groups. Further, the relationship between the physiological and performance characteristics of female players (26 university level 20.8±0.5 years) was examined. The GPS analysis of players during games in terms of low (0-6 km.h-1), moderate (6-14.5 km.h-1) and high intensity (>14.5 km.h-1) activities and Yo-Yo Intermittent Recovery Test level 1 (YYIRT), Interval Shuttle Run Test (ISRT), Multi-Stage Fitness Test (MSFT), blood lactate (laboratory assessment of speed at 4 mmol.L-1) concentration and VO2max test were assessed. The total distance covered during a match was associated with VO2max, speed at 4 mmol.L-1, YYIRT, ISRT and MSFT performance (Pearson's correlation coefficients; 0.58; 0.67; 0.67; 0.61; 0.58, respectively, *P*<0.05 in all cases). Mean speed was also related to VO2max, speed at 4 mmol.L-1, YYIRT, ISRT and MSFT (Pearson's correlation coefficients: 0.58; 0.71; 0.61; 0.62; 0.54 respectively, *P*<0.05 in all cases). The amount of high intensity activity, which may be an indicator of the quality of match performance was most closely associated with VO2max, YYIRT and ISRT (Pearson's correlation coefficients: 0.60; 0.60; 0.54 respectively, *P*<0.01 in all cases). Further the study was extended to find the physiological, skill and match performance characteristics of three different competitive levels of female field hockey players. The players were recruited from the 1st (n=13), 2nd (n=10) and 3rd (n=16) teams of Loughborough University Ladies Hockey Club. Players completed field based physiological assessments (YYIRT, ISRT, MSFT and 5,10, 20 and 30 m sprints) and a field based hockey specific dribbling test. Laboratory measures included treadmill VO2max and a submaximal speed lactate test. Results from comparisons between teams did not indicate any differences based on any physiological or match performance parameters ($P>0.05$ in all cases). Superior dribbling skill, as assessed during a hockey-specific skill test, discriminated 1st team from 2nd and 3rd team players (2.58±*0.22* *vs*. 4.43±*0.28* and 3.90±*0.27* s, $P<0.01$, 1st *vs.* 2nd and 1st *vs.* 3rd). These results suggest that skill is crucial to determining success in competitive field hockey. Based on the investigations outlined above it appears a relatively high maximal oxygen uptake is a prerequisite for elite level players from junior to senior levels, although it probably does not distinguish between playing standards. In contrast both short distance speed and skill would seem to discriminate between different standards of field hockey performance. Therefore, in order to succeed at the elite level of field hockey players must possess a certain degree of speed, aerobic power and hockey specific dribbling ability.

Lythe (2008) examined the physical demands of elite men's field hockey via GPS technique and heart rate monitor and the effects of differing substitution methods on the physical and technical outputs of strikers during match play was assessed from team performance statistics. To achieve the purpose the following striker condition were assessed: 3 strikers with no substitutions, 4 strikers with a moderate amount of substitutions and 5 strikers with a large amount of substitutions during 5 matches between the New Zealand men"s hockey team and Tasmania state representative team. Average total distance covered during 70 minutes by a position was 8160 ± 428m of which 479 ± 108m (6.1%) was performed at speeds greater than 19km.h-1. Within this high intensity distance were 34 ± 12 sprints per player with an average duration of 3.3s. Average match HR was 85.3 ± 2.9% HRmax and average peak HR was 96.3 ± 2.7% HRmax. Distance covered decreased by 6.2% between the 1st and 2nd halves and there was a trend of decreasing distance in both halves when total distance was broken into five-minute time periods. When assessing the impact of substitutions on the performance of strikers it was found that there were no significant differences in physical outputs between conditions with total distance (S5 = 8414 ± 125m, S4 = 8422 + 34m; S3 = 8282m) and distance covered at speeds greater than 19km.h-1(S5 = 701 ± 46m, S4 = 685 ± 28m, S3 = 723m) being similar. Substantial differences were found in technical outputs between the substitution conditions with more strikers and greater substitutions offering a better total output than less strikers and fewer substitutions (S5 = 241 ± 35, S4 = 207 ± 38, S3 = 173) but statistical significance between conditions was also not found. In conclusion, the results suggest that although substitutions are not a means to increase the physical work of strikers they do appear to be a way to enhance the contributions that strikers are making to the game.

Stagno (2005) investigated the physiology of field hockey, with special reference to the quantification and prescription of training. The research was investigated the efficacy of training regimes and physiological assessment techniques for field hockey. This investigation consists of six studies. The study I compare the effect of two training regimens (eight weeks) were short duration interval training (SIT) and long duration interval training (LIT) on physiological parameters in male field hockey players. The result of study was showed that SIT offers a more effective use of training time than LIT during pre season. Furthermore, anaerobic capacity was increased only after SIT. The Study II had double purpose; one was measure the physiological profiles of the field hockey players who underwent the SIT programme during Study I; next, to monitor intensity of exercise during competitive games. The physiological variables of players did not change during the competition. The Study III were focused to adapt training (TRIMP) method and to examine the relationship between modified TRIMP (TRIMPMOD) and changes in physiological profile of field hockey players during a competitive season. The percentage change in "O2peak and VOBLA correlated with mean weekly TRIMPMOD (r = 0.801 and r=0.713, respectively). The results of this study show that TRIMPMOD presents an approach to quantify training load during team sports of a high intensity intermittent nature, such as field hockey. The Study IV was used to compare different kinds of small sided games (SSG) and interval training (ITG) sessions and examine the physiological demands of all. further, the study investigate whether SSG alternative form (intensity of 90-100 % VO2max) of aerobic training during the competitive phase of the season. The result of the Study IV clearly indicate that SSG as an aerobic training tool. Study V investigated the reliability and validity of modified shuttle run test for assessing fitness in male field hockey players. The results indicate that the 5m PST is both reliable and valid in measuring fitness levels of field hockey players. The purpose of Study VI were investigate the physiological adaptations to SSG and interval training of players and compare the changes observed on physiological measures with the results from the 5m PST. Study VI confirmed SSG as a suitable conditioning tool for aerobic development and the 5m PST as a sensitive measuring track in VO2peak and anaerobic capacity following a period of training. This investigation provides important information to physiologists, coaches and players alike regarding the physiological demands of the modem field hockey game and presents valuable recommendations as to the various forms of training available to enhance performance.

Reilly and Borrie (1992) explained field hockey is a sport with a long history that has undergone quite rapid and radical change within the past decade. The advent of the synthetic playing surface has changed the technical, tactical and physiological requirements of the game at all levels, but in particular at the elite level. In order to cope with the technical evolution within the game, the hockey player has also had to develop physiologically to meet the physical standards required at elite levels. Analysis of the physiological cost and energy expenditure of playing hockey has placed it in the category of 'heavy exercise', with reported V02 values during a game of 2.26 L/min, Energy expenditure has been estimated to range from 36 to 50 kl/min. Physiological profiling of female hockey players has shown that somatotype tends towards 3.5/4.0/2.5. Figures for percentage body fat in female players range from 16 to 26%. Anaerobic power output has been shown to compare favourably with other groups of sportswomen and has also been shown to be a discriminating factor between elite and county level female players. Aerobic power amongst female players has been shown to range from 45 to 59 ml/kg/min, the reported somatotypes of male hockey players have shown considerable variation but there seems to be a trend away from ectomorphy towards mesomorphy. Anaerobic power output in male players has been shown to be the same as that of soccer players and better than other sports, e.g. basketball and also higher than reference norms. The range of aerobic power reported in the literature is 48 to 65 ml/kg/min and it would appear that an aerobic power in excess of 60 ml/ kg/min is required for elite level play. The physical strain of hockey play has been shown to be considerable, in particular with respect to spinal shrinkage. There is a greater injury risk inherent in playing on synthetic surfaces than on grass.

2.1.3 Game Based Training on Physical Fitness Physiological and Body Composition

Arundhathi et al., (2016) studied the effect of twelve weeks training on selected physical physiological and psychological variables of novice hockey players. To achieve the purpose of the study 20 novice female (age=10-15) hockey players underwent hockey training program five days in a week for a period of 12 weeks. The main objective of the study was to find the effect of training on selected physical, physiological and psychological variables of novice hockey players. the training program was modified or altered week to week from low to complex. The warm up session too varied with the introduction of new drill whereas, the warm down session remained more or less the same. The results of the study showed that regular practicing hockey training improves physical (speed, cardio-respiratory endurance, and flexibility), physiological (Cardiovascular endurance, resting heart rate and body composition) and psychological (mood state and memory) of hockey players.

Ucan (2015) investigated the effects of national-level field hockey on physical fitness and body-composition parameters in Turkish females. To achieve the purpose 24 female subjects (12 healthy controls, aged 19-22, 12 national field hockey players aged 18-21) participated in this study. The data collected from the subjects were body composition, 30-meter sprint, leg power, handgrip strength and posture balance. The statistical analysis showed that there was a significant differences in body-fat percentage ($p < 0.014$), fat mass ($p < 0.044$), speed ($p < 0.000$), leg power ($p < 0.006$), grip strength ($p < 0.022$), but no significant differences in fat-free mass ($p > 0.442$) and fall index ($p > 0.258$) were observed between players and non players. Results indicates that regular hockey practice improves body composition, speed, and lower-and upper-extremity strength, with no effect on fat-free mass and posture balance in young females.

Kumaran and Muthuraj (2012) investigated the effect of short term aerobic and anaerobic training among hockey players. Forty hockey players (Age=18-24, H=160-171cm and W=55-66kg) were selected for this study. They were randomly assigned into two equal (Short term training group and Control group) groups of 20 subjects. The analysis of data revealed that four weeks of short term aerobic and anaerobic training had an impact of 1.54% on aerobic power, 1.76% on anaerobic power.

Gabbett et al., (2009) conducted a study on game-based training for improving skill and physical fitness in team sport athletes. At present, many of them suggested advantages and disadvantages of game-based training based on unreliable evidence. Most of studies have reported that game-based training offers a specific method of conditioning for team sport competition, but it does not replicate on high-intensity and repeated-sprint demands of international competition. Game-based training was safe and effective method of conditioning to improve physical fitness and performance of team-sport athletes than traditional conditioning activities. The technical training associated with a higher volume of skill executions, whilst game-based training has been associated with greater cognitive effort – an important condition for skill learning. Game-based training has better result over skill execution and decision-making than training involving technical instruction. The findings of this study revealed that game-based training one of the appropriate method to improving skill and physical fitness of team sport athletes.

McMillan et al., (2005) investigated physiological adaptations to soccer specific endurance training in professional youth soccer players. The study was established to find physiological adaptations to a 10 week high intensity aerobic interval training program performed by professional youth soccer players, using a soccer specific ball dribbling track. To achieve the purpose 11 youth soccer players (age 16.9 ±0.4 years) were participated high intensity aerobic interval training twice per week for 10 weeks in addition to normal soccer training. The specific training consisted 4×4 min of dribbling a soccer ball around a specially designed track at 90-95% MHR, with a 3 min recovery jog at 70%MHR. The result shows significant improvement on VO2max [63.4 (5.6) to 69.8 (6.6) ml kg(-1) min(-1), or 183.3 (13.2) to 201.5 (16.2) ml kg(-0.75) min(-1) ($p<0.001$)], Squat jump [37.7 (6.2) to 40.3 (6.1)cm, ($p<0.05$)] and counter movement jump [52.0 (4.0) to 53.4 (4.2) cm, ($p<0.05$)]. No significant changes in body mass, running economy, rate of force development, or 10 m sprint times occurred. Finally high intensity intervals dribbling a soccer ball around a specially designed track with regular soccer training is effective for developing the VO2max of soccer players.

2.2 AEROBIC AND ANAEROBIC TRAINING

Gerosa-Neto et al., (2019) compared the effects of two exercise programs performed in different intensities, but equal overall energy expenditure (EE). For this study obese adult men (29.6 ± 4.9 years; BMI = 35.1 ± 3.3 kg/m2) were randomly selected and assigned into 3 groups, High-intensity interval training (HIIT-10 × 1:1 min 100% VO2max; n = 13), Moderate-intensity continuous training (MICT - ˜35 min 65% VO2max; n = 13) and Control (no training; n = 6). The session EE (HIIT = 278.0 ± 37.1; MICT = 299.4 ± 17.8 kcal) was calculated by adding the aerobic contribution (VO2 of the session minus VO2 at rest) and anaerobic (difference between the VO2 estimated and VO2 measured in session). The anaerobic contribution in HIIT was 30%, showing that a substantial portion of the energy for 10 x 1 min HIIT comes from non-oxidative metabolism. The result of the study showed that VO2max improved in both experimental groups ($p = 0.006$), whereas systolic blood pressure decreased ($p < 0.001$) and no changes in diastolic blood pressure. Also there was no alteration in visceral and subcutaneous fat stores, indicating a longer involvement need to be produced changes in adiposity. Finally the study was concluded HIIT or MICT were effective in improving cardiorespiratory fitness and blood pressure in previously inactive obese men.

Sokmen et al., (2018) investigated the effects of sprint interval training with active recovery (SITAR) vs. endurance training (ET) on aerobic and anaerobic power, muscular strength, and sprint ability. To achieve the purpose 42 active adults were randomly assigned to a SITAR or ET group. Both groups underwent their respective training protocols. STAIR group trained 3× per week for 10 weeks at 75% of VO2max for 30 minutes weeks 1–4, with duration increasing to 35 minutes weeks 5–7 and 40 minutes weeks 8–10. While ET ran on a 400-m track without rest for the full training session, SITAR sprinted until the 200-m mark and recovered with fast walking or light jogging the second 200 m to the finish line in 3× original sprint time. Maximal oxygen consumption (VO2max), anaerobic treadmill run to exhaustion at 12.5 km·h−1 at 20% incline, isokinetic leg extension and flexion strength at 60 and 300°·s−1, and 50 m sprint time were determined before and after training. Results showed a significant improvement ($p \leq 0.05$) in absolute and relative VO2max, anaerobic treadmill run, and sprint time in both groups. Only SITAR showed significant improvements in isokinetic leg extension and flexion at 300°·s−1 and decreases in body mass ($p \leq 0.05$). SITAR also showed significantly greater improvement ($p \leq 0.05$) over ET in anaerobic treadmill run and 50 m sprint time. These data suggest that SITAR is a time-efficient strategy to induce rapid adaptations in VO2max comparable to ET with added improvemens in anaerobic power, isokinetic strength, and sprint time not observed with ET.

Patel et al., (2017) Aerobic vs anaerobic exercise training effects on the cardiovascular system. Physical exercise is one of the most effective methods to help prevent cardiovascular (CV) disease and to promote CV health. Aerobic and anaerobic exercises are two types of exercise that differ based on the intensity, interval and types of muscle fibers incorporated. In this article, elaborate on two categories of physical exercise and to help decipher which provides the most effective means of promoting CV health. Both exercises system have produced positive correlations towards improvement of cardiovascular system.

Wewege et al., (2017) observed the effects of high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) on improvements in body composition of overweight and obese adults. To achieve the study 1,334 articles initially screened, 13 were included. These studies evaluated HIIT and MICT in overweight or obese (aged 18–45 years) participant's direct measures (e.g. whole-body fat mass) and indirect measures (e.g. waist circumference) were examined. Studies averaged 10 weeks × 3 sessions per week training. Both training methods showed significant ($p < 0.05$) decreases in whole-body fat mass and waist circumference. There were no differences between groups for any body composition measure. It was concluded that short-term moderate-intensity to high-intensity exercise training bring unexpected improvements on body composition in overweight and obese individuals without accompanying body-weight changes. Both training programme showed similar effect on body composition measures in the mean way HIIT may be a time-efficient component of weight management programs.

Paquette (2017) experimented effects of submaximal and supramaximal interval training on determinants of endurance performance in endurance athletes. The following variables were measured from the subjects before and after the training were maximal oxygen consumption (VO2max), peak power output (Ppeak), and peak and mean anaerobic power. Training programme consists of 6 weeks (3 sessions/week) of submaximal (85% maximal aerobic power [MP], HIIT85, n=8) or supramaximal (115% MP, HIIT115, n = 9) interval training to exhaustion in moderately endurance-trained men. High-intensity training volume was 47% lower in HIIT115 vs HIIT85 (304 ± 77 vs 571 ± 200 min; P < 0.01). The training programme associated with increased VO2max (HIIT85 : +3.3 ± 3.1 mL/kg/min; HIIT115 : +3.3 ± 3.6 ml/kg/min; Time effect P = 0.002; Group effect: P = 0.95), Ppeak (HIIT85 : +18 ± 9 W; HIIT115 : +16 ± 27 W; Time effect P = 0.045; Group effect: P = 0.49), and mean anaerobic power (HIIT85 : +0.42 ± 0.69 W/kg; HIIT115 : +0.55 ± 0.65 W/kg; Time effect P = 0.01; Group effect: P = 0.18). Six weeks of submaximal and supramaximal interval training performed to exhaustion seems to equally improve VO2max and anaerobic power in endurance-trained men, despite half the accumulated time spent at the target intensity.

Weston et al., (2014) conducted a study on low-volume high-intensity interval training (HIT) appears to be an efficient and practical way to develop physical fitness. To achieve the purpose of study (meta-analysis) the data were collected from five data base (PubMed, MEDLINE, Scopus, BIOSIS and Web of Science) contains original research articles published up to January 2014 with the search terms of 'high intensity', 'HIT', 'sprint', 'fitness' and 'VO2max'. The effects of HIT on aerobic power (maximum oxygen consumption [VO2max] in an incremental test) and sprint fitness (peak and mean power in a 30-s Wingate test) were assessed. The selection of the study included criteria were fitness assessed pre- and post-training, training period C2 weeks, repetition duration 30–60s, work-rest ratio-1.0, exercise intensity described as maximal or near maximal and subjects age. The final data set consisted of 55 estimates from 32 trials for VO2max, 23 estimates from 16 trials for peak sprint power, and 19 estimates from 12 trials for mean sprint power. Results of the study proved that mean low-volume HIT protocol (13 training sessions, 0.16 work/rest ratio) in a controlled trial produced a likely moderate improvement in the VO2max of active non-athletic males (6.2 %; 90 % confidence limits ±3.1 %), when compared with control. There were possibly moderate improvements in the VO2max of sedentary males (10.0 %; ±5.1 %) and active non-athletic females (3.6 %; ±4.3 %) and a likely small increase for sedentary females (7.3 %; ±4.8 %). The effect on the VO2max of athletic males was unclear (2.7 %; ±4.6 %). A possibly moderate additional increase was likely for subjects with a 10 mLkg-1min-1 lower baseline VO2max (3.8 %; ±2.5 %), whereas the modifying effects of sex and difference in exercise dose were unclear. The comparison of HIT with traditional endurance training was unclear (-1.6 %; ±4.3 %). Unexplained variation between studies was 2.0 % (SD). Meta-analysed effects of HIT on Wingate peak and mean power were unclear. Finally it was concluded that low-volume HIT produces moderate improvements in the aerobic power of active non-athletic and sedentary subjects.

Manna et al., (2010) examined the effect of training on anthropometric, physiological and biochemical variables of elite field hockey players. To achieve the purpose 30 Indian male field hockey players (age: 23-30 yrs) participated 2 phases of training were preparatory phase (PP, 8 weeks) and competitive phase (CP, 4 weeks). The subjects were completed 4 hrs/day of 5 days/week training which consisting of aerobic, anaerobic and skill development programme. The selected criterion variables were measured at before start of training, at the end of PP and CP. A significant improvement in LBM, back and hand grip strength, serum level of urea, uric acid and HDLC($P<0.05$); and a significant reduction in body fat, sub-maximal exercise heart rate and recovery heart rate, hemoglobin, total cholesterol, triglyceride and LDLC were noted in PP and CP of training when compare to BD ($P<0.05$). No change was noted in stature, body mass, HRmax, resting heart rate, VO2max and anaerobic power of the players after the training.

Laursen (2010) assessed the training for intense exercise performance: high-intensity or high-volume training? The aerobic and anaerobic sources of energy involved during intensive exercise events, such as Olympic rowing, swimming, kayak, track running and track cycling events, etc., Aerobic energy system dominates to supplies energy after ~75s of near maximal effort, and has the greatest possible for development with training, the training methods for these events is generally focused to enhance aerobic metabolic capacity. A short term (6-8 sessions over 2–4 weeks) HIIT (consisting of repeated exercise bouts performed close to or well above the maximal oxygen uptake intensity, interspersed with low-intensity exercise or complete rest) increases in intense exercise performance of 2–4% in well-trained athletes. The influence of high-volume training is less discussed, but its importance should not be downplayed, as high-volume training also induces important metabolic adaptations. While the metabolic adaptations that occur with high-volume training and high-intensity training show considerable overlap, the molecular events that signal for these adaptations may be different. A polarized approach to training, whereby ~75% of total training volume is performed at low intensities, and 10–15% is performed at very high intensities, has been suggested as an optimal training intensity distribution for elite athletes who perform intense exercise events.

Iaia (2009) researched the major effects of aerobic high-intensity and speed-endurance training on physiological and performance of football players, and provides insight on implementation of individual game-related physical training. To measure the physiological components of modern football is highly energetically demanding, and it is important to the players does repeated high-intensity work. Besides, the most successful teams execute high level of high-intensity activities during a game when possession with the ball. Hence, footballers needed high level of physical fitness to handle the physical demands of the game. Studies on football players have shown that 8 to 12 wk of aerobic high-intensity running training (> 85% HR(max)) leads to VO2(max) enhancement (5% to 11%), increased running economy (3% to 7%), and lower blood lactate accumulation during submaximal exercise, as well as improvements in the yo-yo intermittent recovery (YYIR) test performance (13%). Similar adaptations are observed when performing aerobic high-intensity training with small-sided games. Speed-endurance training has a positive effect on football-specific endurance, as shown by the marked improvements in the YYIR test (22% to 28%) and the ability to perform repeated sprints (approximately 2%). The study concluded that aerobic and speed-endurance training were improve high-intensity intermittent exercise performance. It may be varied according to the technical, tactical, and physical demands imposed on each player.

Ferrari (2008) compared sprint vs. interval training in football. The study was assigned to compare the effects of high-intensity aerobic interval and repeated-sprint ability (RSA) training on aerobic and anaerobic physiological variables in male football players. Forty-two participants were randomly divided into two groups and they were undergone either the interval training group (ITG, 4 x 4 min running at 90 - 95 % of HRmax; n = 21) or repeated-sprint training group (RSG, 3 x 6 maximal shuttle sprints of 40 m; n = 21) for 7 weeks. The data measured from the subjects at baseline and after end of training were maximum oxygen uptake, respiratory compensation point, football-specific endurance (Yo-Yo Intermittent Recovery Test, YYIRT), 10-m sprint time, jump height and power, and RSA. There was greater improvemen found in YYIRT (p = 0.003) with RSG (from 1917 +/- 439 to 2455 +/- 488 m) than ITG (from 1846 +/- 329 to 2077 +/- 300 m). Similarly, a significant interaction was found in RSA mean time (p = 0.006) with only the RSG group showing an improvement after training (from 7.53 +/- 0.21 to 7.37 +/- 0.17 s). Significant changes were found in oxygen uptake and respiratory compensation point ($p < 0.05$). These findings suggest that the RSA training protocol was effective training strategy for enhancing aerobic and football-specific training adaptations.

2.3 AEROBIC TRAINING

2.3.1 Aerobic Training on Motor Fitness Variables

Stephen (2012) conducted a case study on training distribution, physiological profile, and performance for a male international 1500-m runner and observed the training delivered by a 1500-m runner and the physiological and performance change during a 2-y period. To achieve the purpose a male international 1500-m runner (personal best 3:38.9 min:s, age 26 y, height 1.86 m, body mass 76 kg) accomplished 6 laboratory tests and 14 monitored training sessions, during 2 training years. Training distribution and volume was determined from training diary and spot-check monitoring of heart rate and accelerometry measurements. In the 1st year, low-intensity training was performed based on prescribed level, which was altered with training and coach support in 2nd year (training zone < 80% of vVO2max, y 1 = 20%; y 2 = 55%). "Tempo" training was also performed at an excessively high intensity (Δ [blood lactate] 5–25 min of tempo run, y 1 = Δ6.7 mM, y 2 = Δ2.5 mM). From 1 to 2 year, there was a concurrent increment in the training on high-intensity zone of 100 to 130% vVO2max from 7 to 10%. The training increased VO2max from 72 to 79 mL · kg−1 · min, economy of running improved from 210 to 206 mL · kg−1 · min, and 1500-m performance time improved from 3:38.9 to 3:32.4 min:s from the beginning of 1st year to the end of 2nd year. This case shows a modification in training methodology that was coincident with a greater improvement in physiological capability and furtherance in performance improvement.

Baquet et al., (2001) conducted a study on high-intensity aerobic training during a 10 week one-hour physical education cycle: effects on physical fitness of adolescents aged 11 to 16. The subjects were divided into a high intensity (HI) group (243 girls and 260 boys) and a control (C) group (21 girls and 27 boys). HI and C completed a weekly 3 hour physical education (PE) session. Before and after a 10-week period, the two groups performed the European physical fitness test battery (EUROFIT). During these 10 weeks HI spent one hour out of three at a specific PE session. These specific sessions consisted of short intermittent exercises (10 seconds) at 100 to 120 % of maximal aerobic speed. They showed a significant influence on standing broad jump (2.9 %, $P < 0.05$, $F = 4.85$), 20 meter shuttle run (3.8 %, $p < 0.001$, $F = 23.21$) and on the maximal distance covered over 7 min (7.6 %, $P < 0.001$, $F = 14.48$). For C there was no improvement in EUROFIT performances. It was concluded that training at high intensity improves not only children's aerobic fitness but also performance of standing broad jump. Well-monitored, adequate intensive training is necessary for a more desirable functional development.

2.3.2 Aerobic Training on Physiological Variables

Hatle et al., (2014) conducted a study on effect of 24 sessions of high-intensity aerobic interval training carried out at either high or moderate frequency, a randomized trial. The purpose of the study was assessed training response of an intensified period of high-intensity exercise. For that this study compared the cardiovascular adaptations of completing 24 high-intensity aerobic interval training sessions carried out for either three or eight weeks, respectively. To achieve the purpose twenty-one healthy subjects (23.062.1 years, 10 females) completed 24 high-intensity training sessions throughout a time-period of either eight weeks (moderate frequency, MF) or three weeks (high frequency, HF) followed by a detraining period of nine weeks without any training. In both training groups the maximal oxygen uptake (VO2max) was evaluated base-line, at the 9th and 17th session and four days after the final 24th training session. In the detraining phase VO2max was evaluated after 12 days and thereafter every second week for eight weeks. Left ventricular echocardiography, carbon monoxide lung diffusion transfer factor, brachial artery flow mediated dilatation and vastus lateralis citrate maximal synthase activity was tested before and after training. The results of study showed that the cardiovascular adaptation after HF training was delayed compared to training with MF. Four days after ending training the HF group showed no improvement (+3.0%, $p = 0.126$), whereas the MF group reached their highest VO2max with a 10.7% improvement (p,0.001: group difference $p = 0.035$). The HF group reached their highest VO2max (6.1% increase, $p = 0.026$) twelve days into the detraining period, compared to a concomitant reduction to 7.9% of VO2max ($p<0.001$) above baseline in the MF group (group difference $p = 0.609$). Finally, the study was concluded that both HF and MF training of high-intensity aerobic exercise improves VO2max. The cardiovascular adaptation following a HF programme of high-intensity exercise is however delayed compared to MF training.

Carey et al., (2007) examined do hockey players need aerobic fitness? relation between VO2max and fatigue during high-intensity intermittent ice skating. The purpose of this study was to assess the relationship between aerobic capacity (VO2max) and recovery from high-intensity intermittent exercise. Totally eleven female collegiate hockey players were participate in this study and they skated 51-lap intervals around the hockey rink at maximal intensity with a 30-second recovery period between skates. The modified Bruce protocol test was administered to fine VO2max and fatigue index was calculated by measuring the total increase in skate time from trial 1 to trial 5. The correlation coefficient between fatigue index and VO2max (-0.422) was not significant ($p > 0.05$) and indicated that only 17.8% of the variance in VO2max could be explained by the fatigue index. The study was concluded that recovery from high-intensity intermittent exercise is not interrelated to aerobic capacity. Therefore, trainers need not much concentrate on aerobic training in their plan, as HIIT already in hockey training also develop aerobic capacity (VO2max).

Talanian et al., (2006) examine the effects of seven high intensity aerobic interval training (HUT) sessions over two weeks on skeletal muscle fuel content, mitochondrial enzyme activities, fatty acid transport proteins, VO2 peak, and whole body metabolic, hormonal and cardiovascular responses to exercise. To achieve the purpose 8 females were participated in the study (22.1 ± 0.2 yrs, 65.0 ± 2.2 kg, V02peak: 2.36 ± 0.24 l/min). The subjects performed a base-line V02peak test and a 60- min cycling trial at -60% V02peak. The training session consisted of 10 bouts×4-min at ~90% V02peak with 2-min rest between exercise. Training increased VO2peak by 13%. Following HUT, plasma epinephrine and heart rate were lower during the final 30-min of the 60-min cycling trial at ~60% pre training VO2peak. HUT significantly increased 36% whole body fat oxidation (PRE: 15.0 + 2.4, POST: 20.4 ± 2.5 g), muscle mitochondrial U-HAD (PRE: 15.44 ± 1.57, POST: 20.35 ± 1.40 mmol/min×kg/wm) and citrate synthase (PRE: 24.45 ± 1.89, POST: 29.31 + 1.64 mmol/min×kg/wm) by 32% and 20%, and unchanged in Resting muscle glycogen, triacylglycerol contents; cytoplasmic HSL protein content was not significantly increased, but net glycogen use was reduced during the post-training 60-min cycling trial. In addition, total muscle FABPpm content increased significantly (25%), while FAT/CD36 content was unaffected following training. In this study concluded that, high intensity aerobic interval training increases in whole body and skeletal muscle capacity for fatty acid oxidation during exercise in moderately active women.

Chtara et al., (2005) investigated the effects of intra-session concurrent endurance and strength training sequence on aerobic performance and capacity. To examine the effects of the sequencing order of individualized intermittent endurance training combined with muscular strengthening on aerobic performance and capacity. To achieve the study 48 male sport students (age 21.4±1.3) years) were divided into five homogeneous groups according to their maximal aerobic speeds (vVO2MAX). Four groups participated in various training programmes for 12 weeks (two sessions a week) as follows: E (n = 10), running endurance training; S (n = 9), strength circuit training; E+S (n = 10) and S+E (n = 10) combined the two programmes in a different order during the same training session. Group C (n = 9) served as a control. All the subjects were evaluated before (T0) and after (T1) the training period using four tests: (1) a 4 km time trial running test; (2) an incremental track test to estimate vVO2MAX; (3) a time to exhaustion test (tlim) at 100% vVO2MAX; (4) a maximal cycling laboratory test to assess VO2MAX. The result of the study reveals that individualized training produced significant improvements in performance and aerobic capacity in the 4 km time trial with interaction effect ($p<0.001$). The improvements were significantly higher for the E+S group than for the E, S+E, and S groups: 8.6%, 5.7%, 4.7%, and 2.5% for the 4 km test (p,0.05); 10.4%, 8.3%, 8.2%, and 1.6% for vVO2MAX (p,0.01); 13.7%, 10.1%, 11.0%, and 6.4% for VO2MAX (ml/kg0.75/min) (p,0.05) respectively. Similar significant results were observed for tlim and the second ventilator threshold (%V˙O2MAX). the study was concluded that circuit training immediately after individualized endurance training in the same session (E+S) produced greater improvement in the 4 km time trial and aerobic capacity than the opposite order or each of the training programmes performed separately.

2.3.3 Aerobic Training on Body Composition Variables

Suman (2016) conducted a study on aerobic exercise programme and reduction in body weight and body mass index (BMI). To achieve the purpose 40 subjects were randomly assigned in two groups- experimental and control groups (20 each). The experimental group underwent eight weeks aerobic exercise and no treatment for control group. The result of the study showed that significantly decreased ($p <0.05$) in body weight and body mass index in experimental group than control group after eight weeks of aerobic programme.

Albuquerque Filho et al., (2014) conducted research on effect of concurrent training on body composition and lipid profile in overweight adolescents. To achieve the purpose seventeen overweight adolescents (age=12 to 15 yrs from both sexes) participated, they were divided into an intervention group (IG) and a control group (CG). In the IG, 7 subjects underwentweekly 3 days of 16 weeks exercise program that consisted of 30 min of resistance exercises, 33 min of aerobic exercise, and a nutritional intervention. The CG consisted of 10 subjects with no treatment. Body mass, height, body mass index, waist circumference, triceps and subscapular skinfold thickness, sum of skinfolds thickness, body fat percentage, fasting glucose, triglycerides, HDL-C, LDL-C, and total cholesterol were measured as well as diet prescription. Intervention programme reduced the body composition and lipid profile and there were no changes in the CG. The findings indicate that concurrent training intervention was one of the best methods to improve body composition, central adiposity and lipid profile.

Mazurek et al., (2014) conducted a study on effects of aerobic interval training versus continuous moderate exercise programme on aerobic and anaerobic capacity, somatic features and blood lipid profile in collegiate females. Regular practicing of physical exercise produce many positive health benefits, including reducing the risk of cardiovascular diseases, metabolic diseases and some cancers, as well as improving the quality of life. The study was examined the effects of 8-week aerobic interval cycle exercise training (AIT) compared to continuous cycle exercises of moderate intensity (CME) on the aerobic and anaerobic capacity, somatic features and lipid profile. Eighty eight volunteers (aged 19.5±0.6 years) were randomly assigned to three groups of organized physical activity (OPA), who exercised 3 times per week in 47 min sessions: Group I underwent AIT training (n=24) consists of 2 series of 6x10 s sprinting with maximal pedalling and active rest pedalling (intensity 65%–75% HRmax), Group II undergone CME training (n=22) corresponding to 65%-75% HRmax, and Group III was acted as control (n=42). Before and after OPA anthropometrics, aero- and anaerobic capacity and lipid profile indices were measured. The result of the study indicates that AIT significantly reduced waist circumference and WHR when compared to CON, and a significantly greater reduction of sum of skinfolds than in CON and CME. Improvement in relative and absolute VO2max was significantly higher in AIT than CON. Work output and peak power output in the anaerobic test independently improved in all groups. OPA was effective only in reducing triglyceride concentrations in CME and CON groups. Finally it was found that 8 weeks of OPA was beneficial in improving somatic and aerobic capacity indices, but AIT resulted in the greatest improvement in somatic indices (waist circumference, WHR, sum of skinfolds) and in VO2max, compared to CME and CON programmes.

Lehri and Mokha (2006) conducted a study on effectiveness of aerobic and strength training in causing weight loss and favourable body composition in females. The study was organized for 120 females, their age ranged from 20 to 40 years. The result of the study showed both the strength training and aerobic exercise programs had great capability for weight management. In addition, aerobic training has been reduced body weight from both the fat and muscle compartments while strength training preserved the lean body mass and reduced the fat compartment and thus caused favourable body composition in females.

2.3.4 Aerobic Training on Game Performance Variables

Bishop and Girard (2013) Determinants of team-sport performance: implications for altitude training by team sport athletes. Team sports are increasingly popular, with millions of participants worldwide. Athletes engaged in these sports are required to repeatedly produce skilful actions and maximal or near-maximal efforts (eg, accelerations, changes in pace and direction, sprints, jumps and kicks), interspersed with brief recovery intervals (consisting of rest or low-intensity to moderate-intensity activity), over an extended period of time (1–2 h). While performance in most team sports is dominated by technical and tactical proficiencies, successful team-sport athletes must also have highly developed, specific, physical capacities. Much effort goes into designing training programmes to improve these physical capacities, with expected benefits for team-sport performance. Recently, some team sports have introduced altitude training in the belief that it can further enhance team-sport physical performance. Until now, however, there is little published evidence showing improved team-sport performance following altitude training

Billaut et al., (2012) conducted a study on enhancing team-sport athlete performance: is altitude training relevant? The study was analyzed field-based team sports, most of matches are composed of short high-intensity with intervals of rest or submaximal exercises extend up to 60-120 minutes. Matches may also be played at moderate altitude where the lower oxygen partial pressure exerts a detrimental effect on performance. The team sports athletes used to practice various training protocols for improving running performance in the term of improving physiology, including aerobic, sprint, repeated-sprint and resistance training. The altitude training empirically explained to athletes and coaches to improve the basic characteristics of speed and endurance. To prepare for competition the endurance athletes is typically used altitude training (hypoxia) for enhance performance at sea level. Several studies over the decades assessed altitude training, which enhanced aerobic power (endurance performance) and also promote an increased anaerobic fitness (sprint capacity). The study was concluded that implementation of altitude training modalities to enhance match physical performances at both sea level and altitude.

Helgerud et al., (2001) examined the effects of aerobic training on performance during soccer match and soccer specific tests. To achieve the purpose of the study 19 male elite junior soccer players (age 18.1 +/- 0.8 yr) were randomly assigned into two groups, namely training group (N = 9) and the control group (N = 10). The specific aerobic training consisted twice per week of 8 weeks of interval training, 4×4 min (at 90-95% MHR) with a 3-min moderate density. The match performance of soccer players were monitored by video before and after training. The training group showed significant improvement on maximal oxygen uptake (Vo2max from 58.1 +/- 4.5 mL.kg-l.min-l to 64.3 +/- 3.9 mL.kg-l.min-l, P<0.01), lactate threshold (from 47.8 +/- 5.3 mL.kg-1.min-l to 55.4 +/- 4.1 mL.kg-1.min-l, P<0.01), running economy (6.7%, P<0.05), distance covered during a match (20%, P<0.01), number of sprints (100%, P<0.01) number of involvements with the ball (24%, P<0.05) and the work intensity (from 82.7 +/- 3.4% to 85.6 +/- 3.1% , P<0.05)during a soccer match and there were no changes in maximal vertical jumping height, strength, speed, kicking velocity, kicking precision, or quality of passes after the training period. The control group showed no changes in any of the tested parameters. The study was concluded that superior aerobic endurance enhanced soccer performance of players.

2.4 ANAEROBIC TRAINING

2.4.1 Anaerobic Training on Motor Fitness Variables

Sharma and kailashiya (2018) investigated effects of 6-week sprint-strength and agility training on cardiovascular, body composition and physiological parameters of male field hockey players. To achieve the present interventional study twenty-four young Indian national hockey players selected for this study. The short and effective training proved significant improvements in body composition, cardiovascular, aerobic, anaerobic, strength, agility, and performance-related parameters. The findings will be useful for coaches, players, and also for general population for better, individual, and sport-based designing of "short yet effective" training programs and monitoring of outcomes.

Amrinder et al., (2014) examined the effects of 4-week plyometric training on two different surfaces, sand and grass on muscle soreness and selected sport-specific performance variables in national level hockey players. 40 subjects were randomly divided into two-grass training group (N=20) and sand training group (N=20). After the completion of pre test plyometric training was given for 3/week of 4-weeks. Muscle soreness was assessed at the end of each training session on a 7-point likert scale. After completion of training program post test were administered on strength, endurance, balance and agility. Data clearly indicate that there was no significant changes between two groups ($p>0.05$), in the same time training on sand group experienced less muscle soreness ($p<0.05$) than grass group. The result showed that there was significant improvement ($p<0.05$) on tested variables in both groups. These findings suggest that short-term plyometric training on sand/non-rigid surface produce similar developments in strength, endurance, balance and agility as on firm surface but induces significantly less muscle soreness. Hence, plyometric training on sand is viable option for coaches to enhance performance in athletes, while reducing risk of muscle soreness and damage.

Meckel et al., (2012) organized a study to compare the effect of short-sprint repetition (SST) and long-sprint repetition (LST) trainings on selected fitness components in young soccer players. To achieve the purpose thirty young (14-15 years) soccer players were divided into two groups either SST or LST. The 2 training programs consisted of 4-6 sets of 4 × 50-m all-out sprint (SST) and 4-6 sets of 200-m run at 85% of maximum speed (LST), each performed 3 times a week for a period of 7 weeks. In baseline there were no difference between-groups in predicted VO2max, standing long jump, 30-m sprint time, 4 × 10-m shuttle running time, and 250-m running time. Both training programs were significantly improved VO2max [(predicted from the 20-m shuttle run, $p < 0.01$)] and anaerobic fitness variables of 30-m sprint time ($p < 0.01$), 4 × 10-m shuttle running time ($p < 0.01$), and 250-m running time ($p < 0.01$), without difference between-groups. None of the training effects on standing long jump ($p = 0.21$). The study showed that long, near-maximal sprints, and short, all-out sprint training, matched for total distance, are equally effective in enhancing both the aerobic and anaerobic fitness of young soccer players.

Lockie (2012) conducted a study on 6-week base strength training program for sprint acceleration development and foundation for future progression in amateur athletes. This program can concurrently enhance base lower-body strength and 10-m speed and incorporates the back squat, step up, cable hip flexion, and smith machine calf raise. Loads can be increased from approximately 75–90% of one repetition-maximum over the course of the program. The exercises are described with supporting scientific evidence for their use. Additionally, suggestions are provided as to how the program could be modified and progressed with different exercises to further enhance the force–velocity profile. It was concluded that resistance training program described here can be used to improve base lower-body strength and sprint acceleration in the amateur athlete.

Buchheit et al., (2010) examined improving repeated sprint ability in young elite soccer players: repeated shuttle sprints vs. explosive strength training. To compare the effects of two (ExpS vs. RS) training modalities on repeated sprint ability (RSA) 15 elite male adolescents ,(14.5 ± 0.5 years) soccer players performed in addition to their soccer training program, they were divided into two groups RS (n = 7) and ExpS (n = 8) and underwent their respective training once a week for a total of

10 weeks. RS training consisted of 2-3 sets of 5-6 × 15- to 20-m repeated shuttle sprints interspersed with 14 seconds of passive or 23 seconds of active recovery (≈2 $m \cdot s^{-1}$); ExpS training consisted of 4-6 series of 4-6 exercises (e.g., maximal unilateral countermovement jumps (CMJs), calf and squat plyometric jumps, and short sprints). Base-line to post test data collected from the subjects were assessed. Based on result 10 m ($p = 0.22$) and 30m (−2.1 ± 2.0%) sprint were significantly improved in both groups. RS training induced greater improvement in RSA_{best} (−2.90 ± 2.1 vs. −0.08 ± 3.3%, $p = 0.04$) and tended to enhance RSA_{mean} more (−2.61 ± 2.8 vs. −0.75 ± 2.5%, $p = 0.10$, effect size [ES] = 0.70) than ExpS. In contrast, ExpS tended to induce greater improvements in CMJ (14.8 ± 7.7 vs. 6.8 ± 3.7%, $p = 0.02$) and Hop height (27.5 ± 19.2 vs. 13.5 ± 13.2%, $p = 0.08$, ES = 0.9) compared with RS. Improvements in the repeated shuttle sprint test were only observed after RS training, whereas CMJ height was only increased after ExpS. In this study was concluded that RS and ExpS were equally efficient at enhancing maximal sprinting speed, RS training-induced improvements in RSA were likely more related to progresses in the ability to change direction.

Mujika et al., (2009) explore the effect of in-season short-term sprint and power training programs on elite junior soccer players. The study was to examined 2 in-season short-term sprint and power training protocols on vertical countermovement jump height (with or without arms), sprint (Sprint-15m) speed, and agility (Agility-15m) speed in male elite junior soccer players. Highly trained 20 professional soccer players (age 18.3 +/- 0.6 years, height 177 +/- 4 cm, body mass 71.4 +/- 6.9 kg, sum skinfolds 48.1 +/- 11.4 mm) were randomly assigned to either a CONTRAST (n = 10) or SPRINT (n = 10) group. The training program consisted 6 supervised training sessions over 7 weeks. CONTRAST protocol consisted of alternating heavy-light resistance (15-50% body mass) with soccer-specific drills (small-sided games or technical skills). SPRINT training practice used line 30-m sprints (2-4 sets of 4 x 30 m with 180 and 90 seconds of recovery, respectively). No time x training group effect was found for any of the vertical jump and Agility-15m variables ($p > 0.05$). A time x training group effect was found for Sprint-15m performance with the CONTRAST group showing significantly better scores than the SPRINT group (7.23±0.18 vs. 7.09±0.20 m/s, $p < 0.01$). The result of the study reveals that CONTRAST training should be favored to develop speed in the short term for young elite soccer players during the competitive season.

Chapman et al., (2009) conducted a study on efficacy of interval-based training on conditioning of amateur field hockey players. This research investigated the efficacy of time limited and distance-regulated interval training program on sub-elite field hockey players. Subjects for this study comprised of 22 women (26.1 6 4.5 years, 62.8 6 7.4 kg, 1.7 6 0.9 m) and 22 men (22.1 6 3.2 years, 74.9 6 5.4 kg, 1.8 6 0.5 m) field hockey players. The performance tests conducted for the players were standard 20-m multiple stage shuttle run (MSSR), a 1000-m repeated-effort (33) time trial (RTT), and a 100-m repeated-effort (33) shuttle run (RSR) in an ascending pyramid order. The training was administered to the women and men separately after a traditional, single-peak, 4-week mesocycle, with the fourth week for recovery. Training consisted of an average total sprint distance of 3000m per session during a 20-week data collection period, with testing administered pre and post. Initial athlete profiling showed a significant (p, 0.05) gender difference on all performance tests. The result of the study indicates on MSSR were 8.6±2.5 (range 6.7–10.7) and 12.1±2.4 (10.2–13.5) women and men, respectively. The RTT and RSR times for women and men were 5:34±0:30 seconds (4:31–6:21), 5:14±0:30 seconds (4:27–

6:02), 4:12±0:13 seconds (3:50–4:36), and 4:06±0:13 seconds (3:47–6:02), respectively. After 20 weeks of training, a small to moderate effect size (ES) was calculated for the women's (n = 12) MSSR (ES = 0.74) and RSR (ES = 0.50) results. A distinct improvement in the MSSR resulted after training for men (n = 16), with a moderate ES (1.34). In contrast, completion times in RSR were marginally reduced, with a small ES (0.49). The findings demonstrate that a 3000-m interval-based conditioning program, when conducted in conjunction with normal-skill game play training, can lead to significant improvements in player conditioning during a competitive season.

2.4.2 Anaerobic Training on Physiological Variables

Kelly et al., (2018) conducted a study on comparison of sprint interval and endurance training in team sport athletes. Traditional method of high-volume endurance training (ET) is extremely time-consuming to improve aerobic capacity in contrast to low-volume short-duration sprint interval training (SIT) that improves maximal oxygen uptake (VO2max) to a similar extent. Comparative effects of SIT vs. ET in team sport athletes were very few. Club level male Gaelic football players were randomly assigned to SIT (n = 7; 21.6 ± 2.1 years) or ET (n = 8; 21.9 ± 3.5 years) for 6 sessions over 2 weeks. Base-line to post test result in VO2max ($p \leq 0.05$), and high-intensity endurance capacity ($p \leq 0.05$) in SIT (31.0%) and ET (17.2%) increased after 2 weeks of both SIT and ET was observed. Running economy assessed at 8, 9, 10, and 11 km·h−1, lactate threshold and vVO2max were unchanged after both SIT and ET.

Yamagishi and Babraj (2018) conducted a study on effects of recovery intensity on endurance adaptations during sprint interval training (SIT). To achieve the purpose fourteen healthy young adults (male: 9 and female: 5) were grouped into active recovery group (ARG, male: 4 and female: 3) or passive recovery group (PRG, male: 5 and female: 2). After 2-weeks control period, both groups underwent 6 sessions of 4- to 6, 30-second sprints training with 4-minute recovery over 2 weeks. However, only ARG cycled at 40% VO2peak during the 4-minute recovery periods, while PRG rested on the bike or cycled unloaded. After completion of training program, both groups improved 10-km time-trial performance to a similar extent (ARG: 8.6%, $d = 1.60$, $p = 0.006$; PRG: 6.7%, $d = 0.96$, $p = 0.048$) without gains in VO2peak. However, critical power was increased by ARG only (7.9%, $d = 1.75$, $p = 0.015$) with a tendency of increased maximal incremental power output (5.3%, $d = 0.88$, $p = 0.063$). During the training, active recovery maintained VO2 and heart rate at a higher level compared with passive recovery (VO2: $p = 0.005$, HR: $p = 0.018$), suggesting greater cardiorespiratory demands with the active recovery. This study demonstrated that greater endurance performance adaptations are induced with active recovery when performing SIT over a short time frame. The result of the study reveals that, with active recovery, individuals can gain greater training benefits without increasing total training time.

Mohr and Krustrup (2016) investigated anaerobic speed endurance training in competitive soccer players. The purpose of the present study was to examine the effects of additional in-season speed endurance production versus speed endurance maintenance training regimes on performance in competitive male soccer players. 18 male sub-elite players were randomly assigned into speed endurance production (SEP) or speed endurance maintenance (SEM) training (two additional sessions/wk for 4 weeks) during the competitive season. Players performed the Yo-Yo intermittent recovery level 2 test (YYIR2) and a repeated sprint test (RST) pre- and post intervention. Yo-Yo IR2 performance increased ($p<0.001$) by 50 ± 8% and 26 ± 5%

in SEP and SEM, respectively, with greater ($p=0.03$) improvement in SEP. RST performance improved by 2.1 ± 0.3% and 1.3 ± 0.4% in SEP and SEM, respectively, while the RST fatigue index decreased (4.4 ± 0.8 to 3.4 ± 0.5%; $p<0.04$) in SEP only. Peak and average speed during training were higher ($p<0.001$) in SEP than in SEM (24.5 ± 0.3 vs 19.2 ± 0.3 and 15.5 ± 0.1km·h-1 vs 9.4 ± 0.1 km·h-1). Additional in-season anaerobic speed endurance production and maintenance training improves high-intensity exercise performance in competitive soccer players with superior effects of speed endurance production training.

Macpherson and Weston (2015) studied the effect of low-volume sprint interval training on the development and subsequent maintenance of aerobic fitness in soccer players. In this present study has 2 parts. In part 1, 23 players from the same semiprofessional team involved in a 2-wk SIT intervention (SIT, n = 14, age 25 ± 4 y, weight 77 ± 8 kg; control, n = 9, age 27 ± 6 y, weight 72 ± 10 kg). The SIT group performed 6 training sessions of 4-6 maximal 30-s sprints, in replacement of regular aerobic training and control group sustained with their regular training. After the 2-weeks of intervention (part 2) the SIT group was further divided into either intervention (n = 7, 1 SIT session/wk as replacement of regular aerobic training) or control (n = 7, regular aerobic training with no SIT sessions) for a 5-wk period. Pre and post measures were the YoYo Intermittent Recovery Test Level 1 (YYIRL1) and maximal oxygen uptake (VO2max). In part 1, the 2-week SIT intervention had a small beneficial effect on YYIRL1 (17%; 90% confidence limits ±11%), and VO2max (3.1%; ±5.0%) compared with control. In part 2, 1 SIT session/wk for 5 wk had a small beneficial effect on VO2max (4.2%; ±3.0%), with an unclear effect on YYIRL1 (8%; ±16%). It was concluded that, two weeks of SIT extract small improvements in soccer players' high-intensity intermittent-running performance and VO2max, therefore representing a valuable replacement of regular aerobic training.

Hanjabam and Kailashiya (2014) effects of addition of sprint, strength and agility training on cardiovascular system in young male field hockey players: an echocardiography based study. To find training related physiological and cardiovascular changes and adaptations in field hockey players, this study was administered with 30 male field hockey trainees (age: 15.7±1.55 years, range: 13-20 years) underwent training in addition to the their usual routine; a specialized additional training of 2 hours per day- 3 times a week, consisting of sprint, strength-power and agility was included in the schedule. Base-line to post test results showed that lean body mass (LBM) of the participants significantly improved ($P<0.05$) after the 6 week training. Significant reduction ($P<0.05$) was observed in resting heart rate, resting systolic blood pressure, resting diastolic blood pressure, resting double product or rate pressure product. We also found significant changes ($P<0.05$) in the echocardiographic parameters – increase in left ventricular posterior wall thickness, left ventricular ejection fraction; and decrease in left ventricular end-systolic volume. This 6 week specialized additional training developed body composition and cardiovascular functions of the participants.

Tabata et al., (1996) investigate the effects of moderate-intensity endurance and high-intensity intermittent training on anaerobic capacity and ·VO2max. The study was consisted of two training methods using a mechanically braked cycle ergometer. In first, the effect of 6 wk of moderate-intensity endurance training (70% ·VO2max, 60 min·d-1, 5 d·wk-1) on the anaerobic capacity (the maximal accumulated oxygen deficit) and ·VO2max was evaluated. After the training, the anaerobic capacity did not increase significantly ($P > 0.10$), while ·VO2max increased from 53 ± 5 ml·kg-1·min-1 to 58 ± 3 ml·kg-1·min-1 ($P < 0.01$). Second, to quantify the effect of high-intensity intermittent training on energy release, seven subjects performed an intermittent training exercise 5 d·wk-1 for 6 wk. The exhaustive intermittent training consisted of 7-8×20-s exercise at an intensity of about 170% of ·VO2max with a 10-s rest between each bout. After the training period, VO2max increased by 7 ml·kg-1·min-1, while the anaerobic capacity increased by 28%. In conclusion, this study showed that moderate intensity aerobic training that improves the maximal aerobic power does not change anaerobic capacity and that adequate high-intensity intermittent training may improve both anaerobic and aerobic energy supplying systems significantly, probably through imposing intensive stimuli on both systems.

2.4.3 Anaerobic Training on Body Composition Variables

Andreato et al., (2018) reviewed influence of high-intensity interval training on anthropometric variables of adults with overweight or obesity: a systematic review and network meta-analysis. The aim of this study was to assess the effect of high-intensity interval training (HIIT) on anthropometric variables in adults afflicted with overweight or obesity and to compare the effects with those of moderate-intensity continuous training. An online-based search was engaged to evaluate this study. Results of the 857 articles retrieved in the electronic search, 48 met the inclusion criteria. The analyses confirmed that HIIT was effective in reducing body mass (−1.45 kg [95% CI: −1.85 to −1.05 kg]), body mass index (−0.44 kg m−2 [95% CI: −0.59 to −0.30 kg m−2]), waist circumference (−2.3 cm [95% CI: −3.1 to −1.4 cm]), waist/hip ratio (−0.01 [95% CI: −0.02 to −0.00]), body fat percentage (−1.29% [95% CI: −1.70% to −0.87%]) and abdominal visceral fat area (−6.83 cm2 [95% CI: −11.95 to

−1.71 cm2]). It was concluded that high-intensity interval training and moderate-intensity continuous training were produced similar results on body composition.

2.5 STUDIES ON GAME SPECIFIC TRAINING

Timmerman et al., (2019) investigated to creating appropriate training environments to improve technical, decision-making, and physical skills in field hockey**.** The purpose of this study was to find the effects of eight varied small-sided games (SSG) on physical, technical, and decision-making capacity of field hockey players. Thirteen participants played eight different training games consisting of two 7.5-minute halves, where number of players (three per side or six per side) and/or field characteristics (normal game, cage hockey game, possession game, and two-goals game) was manipulated. Match performance was determined by using notational analysis, and physical demands were determined by using GPS analyses. The result of the study indicated that minimize the number of players increased the number of technical actions performed per player and the physical demands of the SSG. The field characteristics of the possession game forced players to control the ball more as a team, its result in more passes (+4.82 passes) and fewer dribbles (-1.48 dribbles) and tackles (-0.69 tackles) compared to the normal play. The two-goals game led to players scoring more goals (+0.61 goals) compared to the normal game, while the cage hockey game increased passing (+1.46 passes) and physical demands (+7.32 meters per minute) compared to the normal game. The study was concluded that specific constraints of the training environment manipulate the physical demands and performance of hockey players.

Cheong et al., (2016) conducted a study on the contextual interference effect using combination sports skills in open and closed skill environments. This study attempted to present conditions that were closer to the real-world setting of team sports. The main purpose of the study to examine the effects of blocked, random and game-based training practices on learning of the field hockey trap, close dribble and push pass. The secondary purpose of the study to examine the effects of environment on the learning of field hockey sport skills according to different practice schedules. A game-based training conducted in an unstable environment and was compared against a blocked and a traditional random practice schedule. In general, all groups improved dribble and push during the acquisition phase when assessed in a closed environment. In the retention phase, there were no differences between the three groups. When assessed in an open skills environment, all groups improved their percentage of successful executions for trapping and passing execution, and improved total number of attempts and total number of successful executions for both dribbling and shooting execution. Between-group differences were detected for dribbling execution with the game-based group scoring a higher number of dribbling successes. The CI effect did not emerge when practicing and assessing multiple sport skills in a closed skill environment, even when the skills were practiced in combination. However, when skill assessment was conducted in a real-world situation, there appeared to be some support for the CI effect.

Alper (2016) investigated heart rate responses during small sided games and official match-play in soccer. There are inadequate researches that compare heart rate (HR) responses of small sided games (SSGs) and official match-play (OM), but SSGs are a match specific type of training. To achieve the purpose twenty-two male soccer players (age=17.4±0.9 years, height=174.9±6.6 cm, body weight=67.7±8.1 kg) participated in this study. The players underwent anthropometric measurements and a maximum running test (RT) followed by five different randomly ordered SSG sessions (3-, 4-, 5-, 7- and 9-a-side with goalkeepers). OMs were also monitored in the fourth week of the study. The results showed that 3-a-side elicited significantly higher HR and %HRmax than other SSGs and OM, whereas 9-a-side resulted in significantly lower HR and %HRmax compared to other SSG formats and OM ($p < 0.05$). In conclusion, 3-a-side, 4-a-side and 5-a-side SSG formats provide players with the opportunity to spend sufficient proportion of time spent in high intensity zones that are specific to match demands.

Süel (2015) studied the effect of skill-based maximal intensity training on power, agility and speed (pas) in female team sport players. To purpose of this investigation 31 (basketball (n=10), handball (n=10) and volleyball (n=11) adult female players were participated skill-based maximal intensity training programs for eight weeks. Base-line to post test data were collected from the subjects on power, agility and speed (PAS) were analyzed with paired t-test and ANOVA test to find the differences between and within groups. In result of the study reveals that, were produced effective improvement on PAS. It was concluded that skill-based maximal intensity training programs can boost training efficiency and provide a competitive advantage for the players.

Casamichana et al., (2012) organized a study on physical demands of friendly matches and small-sided games in semiprofessional soccer players. During this study the Twenty-seven soccer players 7 FMs and 9 sessions involving different SGs were assessed by means of global positioning system technology. Their physical profile was described on the basis of 20 variables related to distances and frequencies at different running speeds, the number of accelerations, and through global indicators of workload such as the work-rest ratio, player workload, and the exertion index. The findings of the study showed that significant differences between SGs and FMs on selected variables. The results shows that included the SGs and FMs during regular training program would enhance foster specific adaptations in the domain of high-intensity effort.

Katis and Kellis (2009) organized a research on effects of small-sided games (SSGs) on physical conditioning and performance in young soccer players. The purpose of the study has two motive, firstly, to examine the movement actions during two different SSGs and secondly, its effect on field endurance and technical tests. To achieve the purpose thirty-four young soccer players (age: 13 ± 0.9 yrs; body mass: 62.3 ± 15.1 kg; height: 1.65 ± 0.06 m) participated in this study. The training consist of three-a-side (3 versus 3 players) and six-a-side (6 versus 6 players) SSGs of 10 bouts of 4 min duration with 3 min active recovery between bouts. The performance of the players was evaluated using five field tests: a) 30m sprint, b) throw-in for distance, c) Illinois Agility Test, d) dribbling the ball and e) horizontal jump before, in the middle and after the implementation of both game situations. The player's heart rate was observed during the entire testing session and each game was filmed to measure soccer movements within the game. The result showed that the three-a-side games had significantly higher heart rate than the six-a-side games and also number of short passes, kicks, tackles, dribbles and scoring goals were significantly higher during the three-a-side compared with the six-aside game ($p < 0.05$). The players executed more number of long passes and headed the ball during the six-a-side ($p < 0.05$). Three-a-side games were significantly decreased in sprint and agility performance ($p < 0.05$), both game conditions significantly modified in the throw-in and the horizontal jump performances were observed ($p < 0.05$). It was concluded that three-a-side games impart higher stimulus for physical conditioning and technical development compared to six-a-side games and their use for training young soccer players is recommended.

2.6 SUMMARY OF LITERATURE

The reviews are presented under the five sections namely studies on field hockey (14), aerobic and anaerobic training (10), aerobic training (14), anaerobic training (n=14) and game specific training (n=5). Studies that are presented in this section prove that varied combinations of aerobic and anaerobic training with game specific drills significantly improved the selected motor fitness, physiological, body composition and skill performance variables.

The literature reviewed by the investigation suggested that the physical and physiological demands of field hockey (**Morris et al., 2019, McGuinness et al., 2018, Kusnanik et al., 2017, Arundhathi et al., 2016, White and MacFarlane 2015, Ucan 2015, Leslie 2012, Kumaran and Muthuraj 2012, Lythe and Kilding 2011, Gabbett et al., 2009, Lythe 2008, McMillan et al., 2005, Stagno 2005** and **Reilly and Borrie 1992**).

The studies were organized to evaluate on combined effects of aerobic and anaerobic training on field hockey, soccer and field based sports by (**Gerosa-Neto et al., 2019, Sökmen et al., 2018, Patel et al., 2017, Wewege et al., 2017, Paquette 2017, Weston et al., 2014, Manna et al., 2010, Laursen 2010, Iaia 2009** and **Ferrari 2008**) significantly produced improvement over the physical, physiological, body composition and skill performance of athletes.

The effect of aerobic training on field hockey/related to field hockey conducted by (**Suman 2016, Albuquerque Filho et al., 2014, Mazurek et al., 2014, Hatle et al., 2014, Bishop and Girard 2013, Stephen 2012, Billaut et al., 2012,**

Carey et al., 2007, Talanian et al., 2006, Lehri and Mokha 2006, Chtara et al., 2005, Baquet et al., 2001 and **Helgerud et al., 2001**) were showed evidence in improvement in motor fitness, physiological, body composition and performance of players.

The literature examined by the investigator suggested that there was significant contribution of anaerobic training in the improvement of selected variables (**Sharma and kailashiya 2018, Kelly et al., 2018, Yamagishi and Babraj 2018, Andreato et al., 2018, Mohr and Krustrup 2016, Macpherson and Weston 2015, Hanjabam and Kailashiya 2014, Amrinder et al., 2014, Meckel et al., 2012, Lockie 2012, Buchheit et al., 2010, Mujika et al., 2009, Chapman et al., 2009, Katis and Kellis 2009** and **Tabata et al., 1996**).

The impact of game specific training on improvement of motor fitness, physiological and performance of field based players were evidentially proved by (**Timmerman et al., 2019, Cheong et al., 2016, Alper 2016, Süel 2015** and **Casamichana et al., 2012**).

The relevant literatures collected from different sources throw ample light with regard to varied combinations of aerobic and anaerobic training with game specific drills on selected motor fitness, physiological, body composition and skill performance variables. The present study may serve as a foundation and main ingredient for future research and investigate the proper training methods for motor fitness, physiological, body composition and skill performance of field hockey players.