CHAPTER II

REVIEW OF RELATED LITERATURE

The review of literature is instrumental in the selection of the topic, formulation of hypothesis and deductive reasoning leading to the problem. It helps to get a clear idea and supports the finding with regard to the problem under study.

The researcher came across several books, periodicals and journals and published thesis, while searching for relevant facts and finding that were related to this present study, such as those were given below or the better understanding and to justify the study.

The related literatures were broadly classified into the following categories:

1. Studies on step aerobics aerobic training
2. Studies on plyometric training
3. Studies on skill performance

2.1 STUDIES ON STEP AEROBIC TRAINING

Noyes FR, et.al.(2011) studied on “a training program to improve neuromuscular in female high school volleyball players” The purpose of this study was to determine if a sports-specific training program could improve neuromuscular indices in female high school volleyball players. Thirty-four athletes (age 14.5 years ± 1.0) participated in the supervised 6-week program, 3 d·wk(-1) for approximately 90-120 minutes per session. The program was conducted on the school's volleyball court and weight room facilities. The athletes underwent a video drop-jump test, multistage fitness test, vertical jump test, and sit-up test before and after training. This program significantly improved lower limb alignment on a drop-jump test, abdominal strength, estimated maximal aerobic power and vertical jump height and may be implemented in high school female volleyball programs.
Rankovic, et.al. (2010), studied on “aerobic capacity as an indicator in different kind of sports “the investigation included the determination of absolute and relative VO2 max in the total of 66 male examines. The examinees were divided in to two groups of active athletes (football players (n=22) and volleyball players (n=18) of different profiles, while the third group of non athletes served as control group. Our results showed that peak values of VO2 max were abtained in football players, and that football as a sport requires higher degree of endurance compared to volleyball. Having considered the morphological and functional changes which are the consequence of the training process, it can be concluded that VO2 max values are statistically significantly higher in the group of athletes compared to the group of non-athletes.

Sheppard JM, et.al. (2010) studied on “the effect of assisted jumping on vertical jump height in high performance volleyball players” The purpose of this study was to evaluate the effects of assisted jump training on counter-movement vertical jump (CMVJ) and spike jump (SPJ) ability in a group of elite male volleyball players. Seven junior national team volleyball players (18.0±1.0 yrs, 200.4±6.7 cm, and 84.0±7.2 kg) participated in this within-subjects cross-over counter-balanced training study. Assisted training involved 3 sessions per week of CMVJ training with 10 kg of assistance, applied through use of a bungee system, whilst normal jump training involved equated volume of unassisted counter-movement vertical jumps. Training periods were 5 weeks duration, with a 3-week wash-out separating them. Assisted jumping may promote the leg extensor musculature to undergo a more rapid rate of shortening, and chronic exposure appears to improve jumping ability.
Chelly MS, et.al. (2009) studied on “effects of a back squat training program on leg power, jump, and sprint performances in junior soccer players” twenty two male soccer players participated in this investigation and were in to two groups. A resistance training group (RTG; age 17 ± 0.3 years) and a control group (CG; age 17 ± 0.5 years). Before and after the training sessions (twice a week for 2 months), Wpeak was determined by means of a cycling force-velocity test. Squat jump (SJ), countermovement jumps (CMJ), and 5-jump test (5-JT) performances were assessed. Both typical force-velocity relationships and mechanical parabolic curves between power and velocity increased after the strength training program. Leg and thigh muscle volume and CSA of RTG remained unchanged after strength training. Back half squat exercises, including adapted heavy loads and only 2 training sessions per week, improved athletic performance in junior soccer players. These specific dynamic constant external resistance exercises are highly recommended as part of an annual training program for junior soccer players.

Popadic, et.al. (2009), studied on “maximal anaerobic power test in athletes of different sport disciplines” the aim of this study was to investigate the values of anaerobic energetic capacity variables in athletes engaged in different sport disciplines and to compare them in relation to specific demands of each sport. Wingate anaerobic test were conducted on 145 elite athletes. Three variables were measured as markers of anaerobic capacity: peak power, mean power, and man power. The measured results show the influence of anaerobic capacity in different sports and the referral values of these variables for the elite male athletes.

Kasabalis, et.al. (2005) evaluated the anaerobic power of elite male volleyball players, using the Wingate Anaerobic Test to examine the relationship between anaerobic
powers and jumping performance. Athletes (n=56) and Non athletes (n=53) were divided into three age groups: Adults (18-25 yr.), juniors (15-16 yr.), and Youth (10-11 yr.). Measurements of height, body mass, vertical jump and Wingate scores indicated higher values for athletes. The specific training effects of anaerobic power were more pronounced at the age of 10-11 years than for Non athletes. A significant correlation coefficient between peak power and vertical jump was found for Athletes (r=.86) and for the total group (r=.82). These results indicated that vertical jump may predict the maximal anaerobic power and could be used by coaches as a practical and easy-to-apply field screening test for evaluation in volleyball training.

Stanganelli LC, et.al. (2003) studied on “adaptation on jump capacity in Brazilian volleyball players prior to the under-19 world championship” The under-19 Brazilian volleyball national team has achieved great performances at international competitions. Because the vertical jump capacity is critical for success in volleyball, the purpose of this study was to identify the training-induced adaptations on jump capacity assessed by general and specific tests during 3 different moments (i.e., T1, T2, and T3) of a macro cycle of preparation for the world championship. In conclusion, this study showed that there were progressive and significant training-induced adaptations, mainly on the tests that simulated the specific skills, such as spike and block, with the best results being reached after the first 9 weeks of training. This probably reflected not only the individual's capacity to adapt, but also the characteristics of the training loads prescribed during the entire macro cycle.

Kasabalis A, et.al. (2002) studied on “relationship between anaerobic power and jumping of selected male volleyball players of different ages” The aim of the present study was to evaluate the anaerobic power of elite male volleyball players, using the
Wingate Anaerobic Test to examine the relationship between anaerobic power and jumping performance. Athletes (n=56) and Non athletes (n=53) were divided into three age groups: Adults (18-25 yr.), juniors (15-16 yr.), and Youth (10-11 yr.). Measurements of height, body mass, vertical jump and Wingate scores indicated higher values for athletes. The specific training effects of anaerobic power were more pronounced at the age of 10-11 years than for Non athletes. A significant correlation coefficient between peak power and vertical jump was found for Athletes (r=.86) and for the total group (r=.82). These results indicated that vertical jump may predict the maximal anaerobic power and could be used by coaches as a practical and easy-to-apply field screening test for evaluation in volleyball training.

Bhanot, et.al. (1989) conducted a study on maximal anaerobic power of Indian Players. The comparative study on aerobic power of different sports was conducted using 99 National Senior as well as National Junior players who were specialized in hockey and football (field games) volleyball and basketball, (court games). The maximal anaerobic power of the players was determined from maximal vertical velocity and body weight by the methods of Margaria. The football players have been found to be highest followed by hockey, volleyball and basketball players in vertical velocity. It is observed that field game players are higher than the court game players in vertical velocity and that volleyball players possess higher maximum anaerobic power than football, hockey and basketball players. In volleyball players, peak power was underestimated using the three equations (1246±78 W, p<10(-4); 4314±216 W, p<0.001; 4607±251, p<0.005; for the Lewis, Harman and Sayers equations, respectively, versus 5355±522 W for the force platform).
The results of the present study demonstrate the difficulty in choosing the most relevant equation in the jump power calculation.

2.2 STUDIES ON PLYOMETRIC TRAINING

The studies related to effect of plyometric training on criterion measures used in the present study were as follows.

**Newton Ru, et.al. (2010)** studied on “effects of ballistic training on preseason preparation of elite volleyball players” The purpose of this study was to determine whether ballistic resistance training would increase the vertical jump (VJ) performance of already highly trained jump athletes. Sixteen male volleyball players from a NCAA Division I team participated in the study. A Vertec was used to measure standing vertical jump and reach (SJR) and jump and reach from a three-step approach (AJR). Several types of vertical jump tests were also performed on a Plyometric Power System and a force plate to measure force, velocity, and power production during vertical jumping. The subjects completed the tests and were then randomly divided into two groups, control and treatment. All subjects completed the usual preseason volleyball on-court training combined with a resistance training program. In addition, the treatment group completed 8 wk of squat jump training while the control group completed squat and leg press exercises at a 6RM load. Both groups were retested at the completion of the training period. These results lend support to the effectiveness of ballistic resistance training for improving vertical jump performance in elite jump athletes.

**Zic G, et.al. (2010)** studied on “vertical jump in female and male volleyball players: a review of observational and experimental studies” The main purpose of this article was to review a series of studies (n=32; 24 observational and eight experimental)
examining vertical jump (VJ) performances in female and male volleyball players. The main findings of this review are (a) players of better performing teams have higher VJ values; (b) strength and conditioning programs that emphasize plyometric training can increase VJ performance; and (c) it is important to continue conditioning sessions throughout the season in order to maintain VJ performance. Three research limitations associated with the testing protocols and the strength and conditioning programs used in the studies were outlined: (a) the use of multiple testing protocols; (b) lack of experimental studies; and (c) lack of data on the effect of VJ performance on achieving success in actual games. Four recommendations for volleyball and strength and conditioning coaches were given: (a) Plyometric training should be included in the annual training program; (b) Interruptions in the conditioning program during the season should be avoided; (c) Overtraining during the pre-season should be avoided; and (d) VJ performance should be tested throughout the entire season.

Mihhalik JP, et.al. (2010) studied on “comparing short term complex and compound training programs on vertical jump height and power output” The purpose of this study was to determine whether there were differences in vertical jump height and lower body power production gains between complex and compound training programs. Thirty-one college-aged club volleyball players (11 men and 20 women) were assigned into either a complex training group or a compound training group based on gender and pre-training performance measures. Both groups trained twice per week for 4 weeks. Work was equated between the 2 groups. Complex training alternated between resistance and plyometric exercises on each training day; whereas, compound training consisted of resistance is training on one day and plyometric training on the other. The results of this study suggest that performing a
minimum of 3 weeks of either complex or compound training is effective for improving vertical jump height and power output; thus, coaches should choose the program which best suits their training schedules.

**Montgomery PG, et.al. (2010)** studied on “the physical and physiological demands of basketball training and competition” Male basketball players (n=11; 19.1±2.1 y, 1.91±0.09 m, 87.9±15.1 kg; mean±SD) completed offensive and defensive practice drills, half court 5on5 scrimmage play, and competitive games. Heart rate, VO2, and triaxial accelerometer data (physical demand) were normalized for individual participation time. Data were log-transformed and differences between drills and games standardized for interpretation of magnitudes and reported with the effect size (ES) statistic. There was no substantial difference in the physical or physiological variables between offensive and defensive drills; physical load (9.5%; 90% confidence limits±45); mean heart rate (-2.4%; ±4.2); peak heart rate (-0.9%; ±3.4); and VO2 (-5.7%; ±9.1). Physical load was moderately greater in game play compared with a 5 on 5 scrimmage (85.2%; ±40.5); with a higher mean heart rate (12.4%; ±5.4).

**Bishop DC, et.al. (2009)** studied on “effect of plyometric training on swimming block start performance in adolescents” This study aimed to identify the effect of plyometric training (PT), when added to habitual training (HT) regimes, on swim start performance. After the completion of a baseline competitive swim start, 22 adolescent swimmers were randomly assigned to either a PT (n = 11, age: 13.1 ± 1.4 yr, mass: 50.6 ± 12.3 kg, stature: 162.9 ± 11.9 cm) or an HT group (n = 11, age: 12.6 ± 1.9 yr, mass: 43.3 ± 11.6 kg, stature: 157.6 ± 11.9 cm). For both baseline and post-trials, swim performance was recorded using videography (50 Hz Canon MVX460) in the capital plane of motion. Considering the practical
importance of a successful swim start to overall performance outcome, the current study has found that inclusion of suitable and safely implemented PT to adolescent performers, in addition to HT routines, can have a positive impact on swim start performance.

**Carlson K, et.al. (2009)** studied on “effect of various training modalities on vertical jump” Subjects were 37 intercollegiate athletes assigned to one of four training groups: strength (S), strength-plyometric (P), strength-VertiMax without arms (VNA), and strength-VertiMax with arms (VA). Each group completed a 6-week training program. The findings of this study demonstrate that there is no difference in vertical jump among strength training, plyometric training, and jump training over a 6-week timeframe.

**De Villarreal ES, et.al. (2009)** studied on “determining variables of plyometric training for improving vertical jump height performance” Plyometric training improves vertical jump height (VJH). However, the effectiveness of plyometric training depends on various factors. However, no extra benefits were found to be gained from doing plyometrics with added weight. The responses identified in this analysis are essential and should be considered by strength and conditioning professionals with regard to the most appropriate dose-response trends for optimizing plyometric-induced gains.

**Khlifa R, et.al. (2008)** studied on “effects of a plyometric training program with and without added load on jumping ability in basketball players” Twenty-seven players were randomly assigned to 3 groups: a control group (no plyometric training), plyometric training group (PG), and loaded plyometric group (LPG, weighted vests 10-11% body mass). Before and after the 10-week training program, all the players were tested for the 5-jump test (5JT), the squat jump (SJ), and the countermovement jump (CMJ). The PG and LPG groups performed 2 and 3 training sessions per week, during the first 3 and the
last 7 weeks, respectively. The results showed that SJ, CMJ, and 5JT were significantly improved only in the PG and LPG groups. The best effects for jumps were observed in LPG (p < 0.01), which showed significantly higher gains than the PG (p < 0.05). In conclusion, it appears that loads added to standard plyometric training program may result in greater vertical and horizontal-jump performances in basketball players.

Vescovi JD, et.al. (2008) studied on “effect of a plyometric program on vertical landing force and jumping performance in college women” Twenty college females who competed recreationally in basketball were randomly assigned to a training (n=10) or control (n=10) group. The absolute change values for vertical ground reaction force, countermovement jump height, peak and average jump power, and peak jump velocity. Comparisons were made using Mann-Whitney U tests. Vertical ground reaction force decreased in the intervention group (-222.8±610.9N), but was not statistically different (p=0.122) compared to the change observed in the control group (54.6±257.6N). There was no difference in the absolute change values between groups for countermovement jump height (1.0±2.8cm vs. -0.2±1.5cm, p=0.696) or any of the associated kinetic variables following the 6-week intervention.

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values between groups for countermovement jump height (1.0±2.8cm vs. -0.2±1.5cm, p=0.696) or any of the associated kinetic variables following the 6-week intervention.

**Brodt V, et.al. (2008)** studied on “countermovement vertical jump with drop steps higher than without in collegiate football players” The vertical jump is a performance test commonly used to assess explosive power and predict athletic ability. Typically, the vertical jump is performed with a countermovement from a stationary stance. We hypothesized that taking a quick step back before initiating the jump, known as the drop-step technique, would result in a higher vertical jump. The purpose of this study was to compare countermovement vertical jumps (CMJs) done from the stationary-stance position to CMJs performed with the drop-step with trained athletes.

**Marques MC, et.al. (2008)** studied on “changes in strength and power performance in elite senior female professional volleyball players during the in-season: a case study” The purpose of this case report is to describe the changes in physical performance after an in-season training regimen in professional female volleyball players in order to determine whether muscular strength and power might be improved. 10 elite female volleyball players completed 2 training sessions per week, which included both resistance training and plyometric exercises. Over the 12-week season, the athletes performed 3-4 sets of 3-8 repetitions for resistance and plyometric exercises during each training session. The current findings suggest that elite female volleyball players can improve strength and power during the competition season by implementing a well-designed training program that includes both resistance and plyometric exercises.

**Mihalik JP, et.al. (2008)** studied on “comparing short term complex and compound training programs on vertical jump height and power output” The purpose of this study
was to determine whether there were differences in vertical jump height and lower body power production gains between complex and compound training programs. Thirty-one college-aged club volleyball players (11 men and 20 women) were assigned into either a complex training group or a compound training group based on gender and pre-training performance measures. Both groups trained twice per week for 4 weeks. Work was equated between the 2 groups. The results of this study suggest that performing a minimum of 3 weeks of either complex or compound training is effective for improving vertical jump height and power output; thus, coaches should choose the program which best suits their training schedules.

Laffaye G, et.al. (2008) studied on “gender bias in the effect of dropping height on jumping performance in volleyball players” The goal of the present study is to investigate in skilled volleyball players (a) the effect of dropping height on women's and men's performance and (b) the drop jump technique with regard to gender. Nine male and 9 female skilled volleyball players were instructed to jump as high as they could; using a drop jump, from a box of 30 cm or from 2 boxes (60 cm). Kinematic and kinetic data were collected using 6 cameras and a force plate. This study shows that women and men have different jump techniques when they drop from a higher position but without increasing the vertical performance. The study findings indicate that it is necessary to find an optimal height for plyometric training for each athlete, allowing enhancement.

Rousanoglou, et.al. (2006) studied on “muscular strength and jumping performance relationship in young women athletes” relationships between muscular strength and vertical jumping performances were examined in young women (14-19 years) track and field jumpers and volleyball players. The knee extension muscular strength measured at
9 knee angles was correlated with jumping height and peak power at the squat and the countermovement and vertical jump. Results indicate the dissimilarity in the relationships between the knee extensor muscular strength and jumping performance in the young female track and field jumpers and volleyball players.

Lidor R, et.al. (2006) studied on “physical and physiological attributes of female volleyball players” The main objective of this article was to review a series of studies (n = 31) on physical attributes, physiological attributes, and on-court performances of female volleyball players. Two practical implications are suggested for volleyball and strength and conditioning coaches: (a) functional and nonfunctional overreaching should be carefully monitored when planning strength and conditioning programs, and (b) volleyball programs should include ballistic-type training.

Martel GF, et.al. (2005) studied on “aquatic plyometric training increases vertical jump in female volleyball players. Nineteen female volleyball players (aged 15 ± 1 yr) were randomly assigned to perform 6 wk of APT or flexibility exercises (CON) twice weekly, both in addition to traditional preseason volleyball training. Testing of leg strength was performed at baseline and after 6 wk, and VJ was measured at baseline and after 2, 4, and 6 wk. Similar increases in VJ were observed in both groups after 4 wk (APT = 3.1%, CON = 4.9%; both P < 0.05); however, the APT group improved by an additional 8% (P < 0.05) from week 4 to week 6, whereas there was no further improvement in the CON group (-0.9%; P = NS). After 6 wk, both groups displayed significant improvements in concentric peak torque during knee extension and flexion at 60 and 180 degrees x s (-1) (all P < 0.05).
**Perez-Gomez J, et.al. (2005)** studied on “effects of weight lifting training combined with plyometric exercises on physical fitness, body composition, and knee extension velocity during kicking n football”. The effects of a training program consisting of weight lifting combined with plyometric exercises on kicking performance, myosin heavy-chain composition (vastus lateralis), physical fitness, and body composition (using dual-energy X-ray absorptiometry (DXA)) was examined in 37 male physical education students divided randomly into a training group (TG: 16 subjects) and a control group (CG: 21 subjects). The TG followed 6 weeks of combined weight lifting and plyometric exercises. In all subjects, tests were performed to measure their maximal angular speed of the knee during in-step kicks on a stationary ball. In conclusion, 6 weeks of strength training combining weight lifting and plyometric exercises results in significant improvement of kicking performance, as well as other physical capacities

**Cronjin JB, et.al. (2005)** studied on “strength and power predictors of sports speed”. The purpose of this study was to identify the relationship between strength and power and measures of first-step quickness (5-m time), acceleration (10-m time), and maximal speed (30-m time). It was suggested that improving the power to weight ratio as well as plyometric training involving countermovement and loaded jump-squat training may be more effective for enhancing sport speed in elite players.

**Martel GF, et.al. (2005)** studied on “aquatic plyometric training increases vertical jump in female volleyball players” Nineteen female volleyball players (aged 15 ± 1 yr) were randomly assigned to perform 6 wk of APT or flexibility exercises (CON) twice weekly, both in addition to traditional preseason volleyball training. Testing of leg strength was performed at baseline and after 6 wk, and VJ was measured at baseline and
after 2, 4, and 6 wk. Similar increases in VJ were observed in both groups after 4 wk (APT = 3.1%, CON = 4.9%; both P < 0.05); however, the APT group improved by an additional 8% (P < 0.05) from week 4 to week 6, whereas there was no further improvement in the CON group (-0.9%; P = NS). After 6 wk, both groups displayed significant improvements in concentric peak torque during knee extension and flexion at 60 and 180 degrees x s(-1) (all P < 0.05). The combination of APT and volleyball training resulted in larger improvements in VJ than in the CON group. Thus, given the likely reduction in muscle soreness with APT versus land-based plyometrics, APT appears to be a promising training option.

Stockbrugger BA, et.al. (2003) studied on “contributing factors to performance of a medicine ball explosive power test a comparison between jump and non jump athletes” The present study examined the factors contributing to performance of a backward overhead medicine ball throw (B-MBT) across 2 types of athletes. Twenty male volleyball players (jump athletes) and 20 wrestlers (no jump athletes) were evaluated on 4 measures of power, including B-MBT, chest medicine ball throw (C-MBT), countermovement vertical jump (CMJ), and power index (PI). The interaction of upper- and lower-body strength and power in the performance of a B-MBT appears complex, with the contributing factors differing for athletes with divergent skill sets and performance demands related to success in football (soccer).

Luebbers PE, et.al. (2003) studied on “effects of plyometric training and recovery on vertical jump performance and anaerobic power” We examined the effects of 2 plyometric training programs, equalized for training volume, followed by a 4-week recovery period of no plyometric training on anaerobic power and vertical jump performance. Physically active, college-aged men were randomly assigned to either a 4-week program.
There were no significant differences between the 2 training groups. Four-week and 7-week plyometric programs are equally effective for improving vertical jump height, vertical jump power, and anaerobic power when followed by a 4-week recovery period. However, a 4-week program may not be as effective as a 7-week program if the recovery period is not employed.

Maffiuttí NA, et.al. (2002) studied on “effect of combined electro stimulation and plyometric training on vertical jump height” Subjects were tested before (week 0), during (week 2), and after the training program (week 4), as well as once more after 2 wk of normal volleyball training (week 6). Different vertical jumps were carried out, as well as maximal voluntary contraction (MVC) of the knee extensor and plantar flexor muscles. At week 2, MVC significantly increased (+20% knee extensors, +13% plantar flexors) as compared to baseline (< 0.05). After the 4-wk training program, different vertical jumps considered were also significantly higher compared to pertaining (< 0.001), and relative gains were comprised between 8-10% (spike-counter movement jump) and 21% (squat jump). The significant increases in maximal strength and explosive strength produced by the present training program were subsequently maintained after an additional 2 wk of volleyball training.

Matavulj D, et.al. (2001) studied on “effects of plyometric training on jumping performance in junior basketball players” Three different training regimens were performed in order to study effects of plyometric training on elite junior basketball players. While control group (CG) participated only in the regular midseason training activity, another two groups performed a limited amount of plyometric training employing drop jumps from the height of either 50 cm (EG-50) or 100 cm (EG-100). The height of the maximal
vertical jump (CMJ), as well as the maximal voluntary force (F) and the rate of force development (RFD) of hip and knee extensors were tested prior to and after the training. An increase in CMJ (4.8 and 5.6 cm in EG-50 and EG-100, respectively), as well as in F of hip extensors and RFD of knee extensors was observed in both experimental groups, while no significant changes were recorded in CG. When the pretest scores were used as a covariate, both experimental groups demonstrated higher increase in CMJ and RFD of knee extensors then CG. However, no differences were observed between EG-50 and EG-100. The multiple correlation between four isometric parameters and CMJ revealed R2=0.29. A limited amount of plyometric training could improve jumping performance in elite junior basketball players and this improvement could be partly related with an increase in F of hip extensors and RFD of knee extensors. However, neither of the two initial heights of the applied drop jumps proved to be more effective.

2.3 STUDIES ON SKILL PERFORMANCE

Gabbett T, et.al. (2011) studied on “changes in skill and physical fitness are following training in talent-identified volleyball players” Twenty-six talented junior volleyball players (mean ± SE age, 15.5 ± 0.2 years) participated in an 8-week skill-based training program that included 3 skill-based court sessions per week. These findings demonstrate that skill-based volleyball training improves spiking, setting, and passing accuracy and spiking and passing technique, but has little effect on the physiological and anthropometric characteristics of players.

Gabbett, et.al. (2008) studied on “do skill-based conditioning games offer a specific training stimulus for junior elite volleyball players”’ investigated the specificity of skill-based conditioning games and compared the effectiveness of skill-based conditioning
games and instructional training for improving physical fitness and skill in junior elite volleyball players. Twenty-five junior volleyball players participated in this study. Heart rate data were collected on all players during the Australian Junior Volleyball Championships. Players were randomly allocated into a skill-based conditioning games group an instructional training group). Each player participated in a 12-week training program that included 3 organized court training sessions per week. Skill-based conditioning games induced improvements in vertical jump, spike jump, speed, agility, upper-body muscular power, and estimated maximal aerobic power, whereas technical instruction improved only spike jump and speed. The results of this study show that skill-based conditioning games offer a specific training stimulus to simulate the physiological demands of competition in junior elite volleyball players. Although the improvements in physical fitness after training were greater with skill-based conditioning games, instructional training resulted in greater improvements in technical skill in these athletes.

Ricarte Batista G, et.al. (2008) studied on “Comparison between vertical jumps of high performance athletes on the brazilian men's beach volleyball team” The sample consisted of 38 male beach volleyball players from the Brazilian Beach Volleyball Circuit of 2006, allocated to two groups according to national ranking of their teams. Anthropometric measures and performance in vertical jumps were assessed using a specific methodology. It is likely that vertical jump height (spike and block) influences the performance of beach volleyball players, and consequently the performance of their teams, since the present study found higher values in G1 than in G2 for the spike jump,
block jump and block difference. However, an athlete's success is not related only to the variables investigated in this study; technical skill, tactics, psychology and physical conditioning can also play a role.

**Gabbett T, et.al. (2007)** studied on “the use of physiological, anthropometric and skill data to predict selection in a talent-identified junior volleyball squad” Twenty-eight junior volleyball players competed for selection in a talent-identification volleyball programme. Participants underwent measurements of stature, standing reach stature, body mass, skinfold thickness, overhead medicine ball throw, vertical jump, spike jump, 5-m and 10-m speed, "T" test agility, maximal aerobic power, and passing, setting, serving, and spiking technique and accuracy. The results of this study demonstrate that selected skill test results (i.e. subjective coach evaluations of passing technique and serving technique), but not physiological and anthropometric data, discriminate between successful and unsuccessful talent-identified junior volleyball players. These results demonstrate the importance of developing passing and serving technique in talent-identified junior volleyball player.

**Lidor R, et.al. (2007)** studied on “accuracy in volleyball service test in rested and physical exertion conditions in elite and near-elite adolescent players” The purpose of this study was to assess a volleyball service test performed not only under a rested condition but also immediately following physical exertion. Twenty-six male adolescent volleyball players (15 elite players of a coherent team [team A; mean age = 16.4 years] and 11 near-elite players of a high school team [team B; mean age = 16.3 years]) performed a service test in a rested condition and following physical exertion. The physical exertion consisted of a block at the net followed by a dig at the 3-m line, both performed twice, and again a block at the net. The players performed 10 consecutive serves under the rested condition and 5 sets of
2 consecutive serves under the physical exertion condition. The points for each serve were allotted according to pre designated target areas. It was concluded that the number of serves hit successfully at the 7-point areas can be used by coaches as the total score of the test.

Forthomme B, et.al. (2005) studied on “factors correlated with volleyball spike velocity” Spike effectiveness represents a determining element in volleyball. To compete at a high level, the player must, in particular, produce a spike characterized by a high ball velocity. Total of 19 male volleyball players from the 2 highest Belgian national divisions underwent an isokinetic assessment of the dominant shoulder and elbow. Ball velocity performance (radar gun) during a spike test, morphological feature, and jump capacity (ergo jump) of the player were measured. We tested the relationship between the isokinetic parameters or physical features and field performances represented by spike velocity. We also compared first-division and second-division player data. Spike velocity correlated significantly with strength performance of the dominant shoulder (internal rotators) and of the dominant elbow (flexors and extensors) in the concentric mode. Positive correlations appeared with both the volleyball players' jump capacity and body mass index.

Gabbett TJ, et.al. (2005) studied on “the development of a standardized skill assessment for junior volleyball players” Thirty junior volleyball players (mean ± SD age, 15.5 ± 1.0 years) participated in this study. Subjects performed tests of spiking, setting, serving, and passing skills on 2 separate occasions to determine test-retest reliability of accuracy. Two expert coaches evaluated the players' technique and reevaluated it 1 month after the initial evaluation to determine the intra tester reliability for technique measurements. A third expert coach determined the inter tester reliability for technique measurements. The validity of the test to discriminate players of different playing abilities was evaluated
by testing junior national, state, and novice volleyball players. Finally, each player participated in an 8-week skill-based training program. Accuracy measurements and intra tester and inter tester ratings of players' technique proved to be highly reproducible (intra class correlation coefficient, r, .85 to .98, range of typical error of measurement 0.2% to 10.0%). A progressive improvement in skill was observed with increases in playing level, while training-induced improvements were present in all skill tasks.

Gusthart JL, et.al. (1993) studied on “Teacher’s instructional variables in volleyball and students improvement in motor skill” The purpose of this study was to examine the relationship between teacher-related process variables as defined by the Qualitative Measures of Teacher Performance Scale and students' learning of three volleyball skills. Teachers of nine classes and 222 students were the subjects. Students were pretested and post tested on the forearm pass, underhand serve, and overhand pass. Aggregate motor scores (summed residuals) were established. Between the testing periods the students received eight lessons in the skills from their regular physical education teachers. All instruction was videotaped and later analyzed. Instructional process was based upon teachers' performance on the scale. Relationships were found between teachers' performance and students' learning for the residual serve, residual forearm pass, and summed residual scores.

Eom HJ, et.al. (1992) studied on “statistical analysis of volleyball team performance” he specific purposes were (a) to examine differences in playing characteristics (in particular, the set and spike) between the Attack Process and the Counterattack Process. Seventy-two sample games from the Third Federation of International Volleyball Cup men's competition were recorded using a computerized recording system. Results showed that the significant differences between Team Standing and Game Outcome were due to better
performances on those skills used in the Counterattack Process. Among the eight selected skills, the block and spike were the most important in determining team success.

Smith, et al. (1992) studied on “physical, physiological and performance differences between Canadian national team and university volleyball players.” Volleyball has been described as an 'interval' sport with both anaerobic and aerobic components. At the higher skill levels, technical performance may be limited by physical characteristics as well as physical fitness, and performance characteristics such as speed and vertical jump. This investigation compared teams at the two uppermost levels of men's volleyball in Canada for differences in physical, physiological and performance characteristics. The subjects were members of the national (n = 15) and university teams (n = 24). The parameters examined included percent body fat, maximal oxygen uptake (VO2 max), anaerobic power, bench press, 20-m sprint time and vertical jumping ability. The only significant difference in physical characteristics between the two teams was in age. Despite similarities in standing and reach height, the national team players had significantly higher block (3.27 vs 3.21 m) and spike (3.43 vs 3.39 m) jumps. An evaluation of anaerobic power measures produced similar power outputs during a modified Wingate test, yet the national team members had higher scores (P less than 0.05) for spike and block jump differences as well as 20-m sprint time. The large aerobic component of elite volleyball play was supported by the high VO2 max value recorded for the national team players (56.7 vs 50.3 ml kg-1 min-1). The results suggest that either years of specific physical conditioning and playing or the selection of individuals for the national team who possess more desirable characteristics as a consequence of genetic endowment, plays a significant role in the preparation of international calibre volleyball players.
Eom, et.al. (1992) studied on “Statistical analyses of volleyball team performance”. The purpose of this study was to investigate the playing characteristics of team performance in international men's volleyball. The specific purposes were (a) to examine differences in playing characteristics (in particular, the set and spike) between the Attack Process and the Counterattack Process; (b) to examine changes in playing characteristics as a function of team success (as indicated by single-game outcomes and by final tournament standings); and (c) to determine the best predictor, or a set of predictors, of team success among the selected skill components. Seventy-two sample games from the Third Federation of International Volleyball Cup men's competition were recorded using a computerized recording system. Results showed that the significant differences between Team Standing and Game Outcome were due to better performances on those skills used in the Counterattack Process. Among the eight selected skills, the block and spike were the most important in determining team success. The methodology used in this study and the subsequent results provide valuable aids for the coach in the evaluation of team performance and ultimately in the preparation of training sessions in volleyball.

Shoenfelt, et.al. (1992) studied on “Evaluation of a mental skills program for serving for an intercollegiate volleyball team”. A preseason mental skills program for serving was implemented for the 11 members of an intercollegiate volleyball team (M age = 20.0 yr.; SD=1.1; years of intercollegiate volleyball experience M=2.6; SD=0.9). Key mental skills taught were relaxation, imagery, attention, focus, goal setting, behavioral modeling, and performance routine. A videotaped behavioral model articulated and demonstrated technical performance keys to effective serving. Players utilized a three-phase service routine to increase automaticity of performance and to incorporate key mental skills.
End-of-season reported use of imagery was significantly correlated with Good Serve Percentage, as was reported use of a service routine. The mean Good Serve Percentage for the season was 49% (SD=7); the team goal was 50%. Serve-specific self-efficacy significantly increased from the pre training program to the end of the season. Results indicated that implementing the mental skills training program was associated with enhanced service performance.

2.4 SUMMARY

The investigator, in this chapter reviewed related literature on effect of aerobic training, anaerobic training and different training methods on selected physical, physiological and skill performance variables.

Further the researcher reviewed on studies on effect of step aerobics and plyometric training.

From these reviews, the investigator found that there was scope for further research to find out the effects of step aerobic plyometric training on selected physical, physiological and skill performance variables among school level male volleyball players.