

## CHAPTER – II

### REVIEW OF RELATED LITERATURE

A literature review is a body of text that aims to review the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Its ultimate goal is to bring the reader up to date with current literature on a topic and forms the basis for another goal, such as future research that may be needed in the area. It gives an overview of what has been said, who the key writers are, what the prevailing theories and hypotheses are, what questions are being asked, and what methods and methodologies are appropriate and useful. As such, it is not in itself primary research, but rather it reports on other findings. The present reviews are based upon the available literature in respect to the study under investigation and therefore confined to the studies to which the investigator has accessed. All the relevant literature thus obtained by the researcher has been presented in this chapter to furnish necessary background material to evaluate the significance of the study. The research scholar has made every possible effort to go through the literatures related to the problem in the aquatic and land plyometric training wherever available. The scholar has gleaned through almost every source like research quarterly, journals of various kinds, periodicals, encyclopaedias, relevant book and e-resources. However, the scholar has also gone through the literatures of allied studies that are related to other games and sports to collect the necessary information for giving a proper shape of the study.

## 2.1. STUDIES ON PLYOMETRIC TRAINING

Saez de Villarreal E, Suarez-Arrones L, Requena B, Haff GG, Ferrete C.(2015) examine the influence of a short-term combined plyometric and sprint training (9-weeks) within regular soccer practice on explosive and technical actions of pubertal soccer players during the in-season. Their study proved that the short-term combined program had a beneficial impact on explosive actions, such as sprinting, change of direction, jumping and ball-shooting speed which are important determinants of match-winning actions in soccer performance. Therefore, we propose modifications to current training methodology for pubertal soccer players to include combined plyometric and speed training for athlete preparation in this sport.

Singh Harmandeep, Kumar Satinder, Rathi Amita and Sherawat Anupriya. (2015) examined a study on effects of six-week plyometrics on vertical jumping ability of volleyball players. They identified that Plyometric training program as more beneficial and effective than general training program and have more positive effect on vertical jump performance

Suresh, Jayalakshmi, Rizwana Begum Nagoor Meeran And Sivakumar (2015) investigate a study on effect of plyometric exercise training on vertical jump height between ground and sand surface in male volleyball players. They conclude that plyometric training on sand as a useful training strategy to improve vertical jump height in volleyball players than plyometric training on ground.

Venkatachalam. K, Loganathan. B (2015) conducted a study on aerobic plyometric circuit training and aerobic physical circuit training on vertical jump performance of volleyball players. Their results revealed significant difference noticed

among the experimental groups as compared to the control group after the completion of the training period on explosive power.

Ramírez-Campillo R et, al, (2015) conducted a study on effect of progressive volume-based overload during plyometric training on explosive and endurance performance in young soccer players. They conclude that ensured significant improvement in muscle explosive and endurance performance measures. However, a progressive increase in plyometric training volume seems more advantageous to induce soccer-specific performance improvements.

Amrinder Singh, Avinash Kumar Boyat and Jaspal Singh Sandhu (2015) investigates a study on effect of a 6 week plyometric training program on agility, vertical jump height and peak torque ratio of Indian taekwondo players. After 6 week of plyometric training program agility, vertical jump height and peak torque ratio was improved significantly in G1 group (plyometric training group). They found that improvement in agility, vertical jump and peak torque ratio of taekwondo players occur after 6 week of plyometric training which will reducing the risk of lower limb injuries.

Aashish Kumar Jain, Madhusudan Tiwari, Aakanksha Jain and Saleem Akhtar Naqvi (2015) conducted a study on the effect of six weeks plyometric training on agility in male basketball players. Their results from the study were very encouraging and demonstrated that the mean of agility test of Experimental Group was better than control group, thus there was significant effect of 6 week plyometric training program on agility in young male basketball players.

Singh Harmandeep et.al (2015) reported plyometric training program as more beneficial and effective than general training program and have more positive effect on vertical jump performance.

Aalizadeh A, et. al, (2015) conducted a study on the effect of short-term plyometric training program on sprint, strength, power and agility performance in non-athletic men they found that the study revealed that in experimental groups, significant increase observed in Swedish swimming, horizontal jumps test and also significant decrease observed in 30 meters speed and test in comparison with control group. Therefore, it seems that plyometric training have been effective on the physical preparation indices and can improve the non athletes' performance.

Ramachandran S, Pradhan B (2014) designed an experiment to determine sport specific training in basketball players should focus on vertical jump height and agility in consistent with demands of the sport. The study concludes that short term two weeks plyometrics training combined with dynamic stretching as a useful sport specific training strategy to improve vertical jump height and agility on trained basketball players.

Ahmed Fadhil Farhan(2014), conducted a study on impact of plyometric training program on physical performance in girls age 12 to 15 years. Thus 6-weeks performing the plyometric training program can enhance physical performance in experimental group, while generally no effect was observed on a series of performance tests in a control group of adolescent female using the usual training program.

Arazi H, Mohammadi M, Asadi A (2014) compared the effects of plyometric training on sand vs. land surface on muscular performance adaptations in men. Their study conclude with regard to ES, it can be recommended that athletes used LDJ training for enhancing sprint and jump and SDJ training for improving agility and strength.

Johnson BA, Salzberg C, MacWilliams BA, Shuckra AL, D'Astous JL.(2014) wanted to evaluate the optimal duration and effects of plyometric training on the gross motor abilities of 3 boys with unilateral spastic cerebral palsy. This study suggests that

plyometric training improves gross motor ability, agility, and upper extremity power in boys with unilateral cerebral palsy. Treatment duration should be determined by an individual's capacity, the task, and the outcome measure.

Eskandar Taheri, Asghar Nikseresht and Ebrahim Khoshnam (2014) investigate a study on the effect of 8 weeks of plyometric and resistance training on agility, speed and explosive power in soccer players. In their study between-groups comparison showed better records in agility, speed and explosive power for plyometric compared with resistance training group after eight weeks. According to the results, they concluded that both plyometric and resistance training exercises increase agility and explosive power and reduce sprint time in football players. Plyometric exercises also showed more favorable effects on study variables compared with resistance exercises. Therefore, these types of training methods are suggested to soccer players and coaches for improving speed and performance skill.

Ramírez-Campillo R et.al. (2014) investigated the efficiency of short-term vertical plyometric training program within soccer practice to improve both explosive actions and endurance in young soccer players. Their results shows an integrated vertical plyometric program within the regular soccer practice can substitute soccer drills to improve most explosive actions and endurance, but horizontal exercises should also be included to enhance sprinting performance.

Ramírez-Campill, Alvarez, Henríquez-Olguín, Baez, Martínez, Andrade, Izquierdo(2014) conducted a study on effects of plyometric training on endurance and explosive strength performance in competitive middle- and long-distance runners. They conclude that properly programmed concurrent explosive strength and endurance training could be advantageous for middle- and long-distance runners in their competitive

performance, especially in events characterized by sprinting actions with small time differences at conducted the end of the race.

Sohnlein Q, Müller E, Stöggl TL (2014) tested plyometric training (PT) programs are widely used to improve explosive actions in soccer players of various ages, although there is debate about optimal training duration and time course of improvement. Plyometric training seems to be an appropriate training tool to enhance some but not all explosive actions. The results indicate that the duration of a PT program is highly dependent on what type of explosive actions should be improved, or whether several explosive actions should be improved at the same time.

Park GD, Lee JC, Lee J (2014) designed an experiment to determine physical strength elements required for athletic throwing events include muscle strength, swiftness, agility, speed, flexibility, and physical balance. Although plyometric training and weight training are implemented as representative training methods for improving swiftness and agility, most studies of it have been conducted with players of other sports. Plyometric training positively affected high school throwing event athletes. To summarize the study findings, the application of plyometric training with high intensity and loads improved the results of athletes who perform highly intensive exercises at normal times.

Ramirez-Campillo R, et.al. (2014) compared the effects of plyometric training using 30, 60, or 120 s of rest between sets on explosive adaptations in young soccer players. Data from this research can be helpful for soccer trainers in choosing efficient drills and characteristics of between sets recovery programs to enhance performances in young male soccer players.

Ramírez-Campillo R et.al.,(2014) investigated the effects of bilateral, unilateral, or combined bilateral and unilateral plyometric training (PT) on muscle power output,

endurance and balance performance adaptations in young soccer players. The current study showed that bilateral, unilateral and combined bilateral and unilateral PT ensured significant improvement in several muscular power and endurance performance measures in young soccer players. However, the combination of unilateral and bilateral drills seems more advantageous to induce superior performance improvements.

Ramírez-Campillo R1, Gallardo F, Henriquez-Olguín C, Meylan C, Martínez C, Álvarez.et,al, (2014) examined the effect of vertical, horizontal and combined plyometric training on explosive, balance and endurance performance of young soccer players. The study demonstrated that vertical, horizontal and combined vertical and horizontal jumps induced meaningful improvement in explosive actions, balance and intermittent endurance capacity. However, combining vertical and horizontal drills seems more advantageous to induce greater performance improvements.

Ramírez-Campillo R1, Henriquez-Olguín C, Burgos C, Andrade D, Zapata D, Martínez C, Álvarez C, Baez EI, et,al., (2014) compared the effects of progressive volume-based overload to constant volume-based overload on muscle explosive and endurance performance adaptations during a bi-weekly short-term (i.e. six weeks) plyometric training intervention in young soccer players. Our results show that PPT and NPPT ensured significant improvement in muscle explosive and endurance performance measures. However, a progressive increase in plyometric training volume seems more advantageous to induce soccer-specific performance improvements.

Creekmur CC, Haworth J, Cox RH, Walsh MS.(2014) conducted a study on the effects of plyometrics performed during warm-up on 20 and 40 meter sprint conducted a study on performance. These results indicate that including a plyometric exercise during

warm-ups can improve sprint performance in collegiate aged male sprinters during short sprints.

Benito-Martínez E et.al. (2013) aimed to examine the effects of training combining plyometrics (PT) and neuromuscular electro stimulation (ES) on speed training and triple jump. Regarding triple jump, the results showed significant improvements in the performance of athletes who used both simultaneous combined training and used ES followed by plyometrics. However, no significant improvement was observed after PT training prior to ES.

Michailidis Y et.al. (2013) designed an experiment to determine whether preadolescent boys exhibit plyometric trainability or not. Their study indicates that (a) prepubertal boys exhibit considerable plyometric trainability, and (b) when soccer practice is supplemented with a PT protocol, it leads to greater performance gains.

Ramírez-Campillo R et.al. (2013) investigated the efficiency of short-term vertical plyometric training program within soccer practice to improve both explosive actions and endurance in young soccer players. They proved that the integrated vertical plyometric program within regular soccer practice can substitute soccer drills to improve most explosive actions and endurance, but horizontal exercises should also be included to enhance sprinting performance.

Yiannis Michailidis. (2013) conducted a study on effect of plyometric training on athletic performance in preadolescent soccer players. Their results indicate that plyometric training can improve running performance at 30 m sprint and the performance at standing long jump in preadolescent soccer players.

Vácz M, Tollár J, Mészler B, Juhász I, Karsai I.(2013) wanted to determine the effects of a short-term in-season plyometric training program on power, agility and knee



extensor strength.. Results of the study indicate that plyometric training consisting of high impact unilateral and bilateral exercises induced remarkable improvements in lower extremity power and maximal knee extensor strength, and smaller improvements in soccer-specific agility. Therefore, it is concluded that short-term plyometric training should be incorporated in the in-season preparation of lower level players to improve specific performance in soccer.

Rodrigo Ramirez Campillo, David Cristobal Andrade (2013) investigates a study on effects of plyometric training volume and training surface on explosive strength. Thus their finding of interest in the study was that after 7 weeks of plyometric training, performance enhancement in maximal strength and in actions requiring fast SSC (such as DJ and sprint) were dependent on the volume of training and the surface on which it was performed. This must be taken into account when using plyometric training on different surfaces.

Moazzam Hussain Khan, Kamran Ali (2013) conducted a study on the effects of grass and clay plyometric training on jumping , sprinting and agility in collegiate cricketers he suggested that both the surfaces can be used to improve the athletes' performances

Aashish Kumar Jain, Madhusudan Tiwari, Aakanksha Jain, Saleem Akhtar Naqvi. (2013) conducted a study on the effect of six weeks plyometric training on agility in male basketball players they found that study were very encouraging and demonstrated that the mean of agility test of experimental group was better than control group, thus there was significant effect of 6 week plyometric training program on agility in young male basketball players.

Yiannis Michailidis. (2013) conducted a study on effect of plyometric training on athletic performance in preadolescent soccer players. Their results indicate that plyometric training can improve running performance at 30 m sprint and the performance at standing long jump in preadolescent soccer players.

Grieco CR, Cortes N, Greska EK, Lucci S, Onate JA (2012) tested the effect of a 10-week combined resistance-plyometric training program on the RE and V[Combining Dot Above]O<sub>2</sub>max in female soccer players. The results suggest a plyometric-agility training program may increase the V[Combining Dot Above]O<sub>2</sub>peak in female soccer players; however, the effect on RE was equivocal.

Eduardo Saez de Villarreal, Bernardo Requena and John Cronin (2012) conducted a study on the effects of plyometric training on sprint performance: a meta-analysis. They concluded that to optimize sprint enhancement, the combination of different types of plyometrics and the use of training programs that incorporate greater horizontal acceleration (i.e., sprint-specific plyometric exercises, jumps with horizontal displacement) would be recommended, rather than using only one form of jump training ( $p < 0.05$ ). No extra benefits were found to be gained from doing plyometrics with added weight. The loading parameters identified in this analysis should be considered by the professional sprinters and specialized trainers with regard to the most appropriate dose-response trends PT to optimized sprint performance gains.

Ozhan Bavli (2012) investigates a study on comparison the effect of water plyometrics and land plyometrics on body mass index and biometrical variables of adolescent basketball players. He found that significant differences were detected on BMI and biomotorical variables between pre-test and post-test results in both water and land plyometric exercise groups. But there were no statistically significant differences between

groups. After the study period there were also statistically significant differences between control and plyometric exercise groups.

Mohamed and El-Mawgoud Elsayed (2012) conducted a study on effect of plyometric training on specific physical abilities in long jump athletes. They found that support that improvements in specific physical abilities and level of long jump can occur in as little as 8 weeks of plyometric training which can be useful during the last preparatory phase before in-season competition for athletes.

Sáez de Villarreal et.al (2012) conducted a study on the effects of plyometric training on sprint performance: a meta-analysis. Their study proved to optimize sprint enhancement, the combination of different types of plyometrics and the use of training programs that incorporate greater horizontal acceleration (i.e., sprint-specific plyometric exercises, jumps with horizontal displacement) would be recommended, rather than using only one form of jump training. No extra benefits were found to be gained from doing plyometrics with added weight. The loading parameters identified in this analysis should be considered by the professional sprinters and specialized trainers with regard to the most appropriate dose-response trends PT to optimized sprint performance gains.

Bal, Baljinder Singh; Kaur, Parminder Jeet; Singh, Davinder (2011) conducted a study on effects of a short term plyometric training program of agility in young basketball players. The results from their study were very encouraging and demonstrated the benefits of short term plyometric training program of agility in young basketball players. It is concluded that the use of plyometrics training program not only to break the monotony of training, but they can also improve the strength of basketball players.

Johnson BA, Salzberg CL, Stevenson DA. (2011) examined a systematic review: plyometric training programs for young children. The research suggests that plyometric

training is safe for children when parents provide consent, children agree to participate, and safety guidelines are built into the intervention.

John Hill, DO, FACSM and Matthew Leiszler, MD. (2011) conducted a study on review and role of plyometrics and core rehabilitation in competitive sport. They suggested that on injury prevention rehabilitation of certain types of injuries. Improvement in performance compared to other types of exercise is unclear at this time. This article discusses the theory and strategy behind core stability and plyometric training; reviews the literature on injury prevention, rehabilitation of injury, and performance enhancement with these modalities; and discusses the evaluation and rehabilitation of core stability.

Hermassi S1, Chelly MS, Tabka Z, Shephard RJ, Chamari K. (2011) looked at the effects of 8-week in-season upper and lower limb heavy resistance training on the peak power, throwing velocity, and sprint performance of elite male handball players. They conclude that in-season biweekly heavy back half-squat, pull-over, and bench-press exercises can be commended to elite male handball players as improving many measures of handball-related performance without adverse effects upon speed of movement.

Bonnette, Spaniol, Melrose, Ocker and Dyer (2011) examined a study on the effect of agility, plyometric, and sprint training on the speed, endurance and power of high school soccer players. Their study reveals that a two-day a week sprint, plyometric and agility training program over four weeks can have positive results on the speed, endurance and power of high school soccer players

Sedano ,Matheu , Redondo and Cuadrado (2011) investigates a study on effects of plyometric training on explosive strength, acceleration capacity and kicking speed in young elite soccer players. Their findings revealed that a 10-week plyometric program

may be an effective training stimulus to improve explosive strength compared to a more conventional physical training program. The improvements in explosive strength can be transferred to acceleration capacity and kicking speed but players need time to transfer these increases.

Chelly MS1, Ghenem MA, Abid K, Hermassi S, Tabka Z, Shephard RJ.(2010) investigated the effects of in-season short-term plyometric training program on leg power, jump- and sprint performance of soccer players.. They conclude that biweekly plyometric training of junior soccer players (including adapted hurdle and depth jumps) improved important components of athletic performance relative to standard in-season training. Accordingly, such exercises are highly recommended as part of an annual soccer training program.

Roopchand-Martin S, Lue-Chin P. (2010) aimed to examine the effect of a three-week plyometric training programme on jump performance and agility in Jamaican national netball players. They proved that the three weeks of Plyometric training can lead to significant improvements in jump performance and agility and should be integrated into the national training programme at intervals yet to be determined.

Chelly MS1, Ghenem MA, Abid K, Hermassi S, Tabka Z, Shephard RJ (2010) wanted to determine the effects of in-season short-term plyometric training program on leg power, jump- and sprint performance of soccer players. They conclude that biweekly plyometric training of junior soccer players (including adapted hurdle and depth jumps) improved important components of athletic performance relative to standard in-season training. Accordingly, such exercises are highly recommended as part of an annual soccer training program.

Chetna Chaudhary and Birendra Jhajharia (2010) examined a study on effects of plyometric exercises on selected motor abilities of university level female basketball players. They was concluded that the plyometric training is an effective means for improving the following variables: agility, flexibility vertical jump and movement speed. On the other hand, plyometric training is not an effective means for improving the variable, that is, speed of movement (20-m dash). There was no significant improvement in case of control group.

Bhuvanendhiran and Sudhan Paulraj (2010) conducted a study on effect of plyometric training on speed, stride length and stride frequency. His study found that the result of the better improvement was in speed, stride length and stride frequency due to plyometric training.

John Shaji and Saluja Isha (2009) conducted a study on comparative analysis of plyometric training program and dynamic stretching on vertical jump and agility in male collegiate basketball player. He found that two days of plyometric training a week in combination with dynamic stretching for four weeks is sufficient enough to show improvements in vertical jump height and agility. The results also suggest that two days of plyometric training and dynamic stretching are equally effective in improving vertical jump height. In contrast dynamic stretching two days a week for four weeks was not sufficient enough to show improvements in agility while plyometric training was sufficient.

Kevin Carlson, Marshall Magnusen & Peter Walters. (2009) investigate a study on effect of various training modalities on vertical jump. The findings of this study demonstrate that there is difference in vertical jump among strength training, plyometric training, and jump training over a 6-week timeframe.

Meylan C1, Malatesta D. (2009) tested the effects of in-season plyometric training within soccer practice on explosive actions of young players. The current study demonstrated that a plyometric program within regular soccer practice improved explosive actions of young players compared to conventional soccer training only. Therefore, the short-term plyometric program had a beneficial impact on explosive actions, such as sprinting, change of direction, and jumping, which are important determinants of match-winning actions in soccer performance.

Thomas K, French D, Hayes PR (2009) compared the effects of two plyometric training techniques on power and agility in youth soccer players. The study concludes that both DJ and CMJ plyometrics are worthwhile training activities for improving power and agility in youth soccer players.

Shankar, Rajpal, and Arora (2008) conducted a study of effect of high intensity and low intensity plyometric on vertical jump height and maximum voluntary isometric contraction in football players. They found out that high Intensity Plyometric training has significant effect on Vertical Jump Height and Maximum Voluntary Isometric Contraction as compared to Low Intensity Plyometric.

Dodd DJ, Alvar .(2007 ) designed an experiment to determine the effects of complex training vs. heavy resistance or plyometric interventions alone on various power-specific performance measures. The present results indicate that complex training can provide strength and conditioning professional's equal, if not slightly greater, improvements in muscular power than traditional heavy resistance- and plyometric-only interventions in moderately trained athletes. Complex training can be another valuable method for short-term power and speed improvements in athletes in isolation or in conjunction with other power development methods.

Avery D. Faigenbaum, James E. McFarland, et al, (2007) wanted to compare the effects of a six week training period of combined plyometric and resistance training or resistance training alone on fitness performance in boys. These findings suggest that the addition of plyometric training to a resistance training program may be more beneficial than resistance training and static stretching for enhancing selected measures of upper and lower body power in boys.

Ramachandran S, Pradhan B.(2007) conducted a study on effects of short-term two weeks low intensity plyometrics combined with dynamic stretching training in improving vertical jump height and agility on trained basketball players. They found that short term two weeks plyometrics training combined with dynamic stretching as a useful sport specific training strategy to improve vertical jump height and agility on trained basketball players.

Michael G, et al (2006) conducted a study on the effects of a 6-week plyometric training program on agility. Their found that this study shows that plyometric training can be an effective training technique to improve an athlete's agility.

Marginson V, Rowlands AV, Gleeson NP, Eston RG(2005) aim to compare symptoms of exercise-induced muscle damage after an initial and repeated bout of plyometric exercise in men and boys. Explanations for milder symptoms of exercise-induced muscle damage in children include greater flexibility leading to less overextension of sarcomeres during eccentric exercise, fewer fast-twitch muscle fibers, and greater and perhaps more varied habitual physical activity patterns.

Raj Kumar & Harish Kumar (2005) conducted a study on effect of six-weeks of plyometric circuit training on the jumping performance of female college players. They found that plyometric jump training improved a explosive power.



Faigenbaum . (2003) made attempted effects of a short-term plyometric and resistance training program on fitness performance in boys age 12 to 15 years. They found that the addition of plyometric training to a resistance training program may be more beneficial than resistance training and static stretching for enhancing selected measures of upper and lower body power in boys. He found that the effects of resistance training and plyometric training may be synergistic in children, with their combined effects being greater than each program performed alone.

Matavulj, Kukolj, Dusan Ugarkovic and Slobodan Jaric (2001) conducted a study on effects on plyometric training on jumping performance in junior basketball players. They found that 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.

Miltenberger, Matthew, Lopez, Rebecca (2000) conducted a study on plyometric training effects on athletic performance in youth soccer athletes: a systematic review plyometrics and youth soccer performance. They conclude that similarities and differences in methodologies and procedures among the included studies.

## **2.2 STUDIES ON AQUATIC PLYOMETRIC TRAINING**

Nisith K. Datta, Rakesh Bharti (2015) conducted a study on effect of aquatic plyometric training on selected physical fitness variables in intercollegiate male handball players. The result of their study indicates due to aquatic and land plyometric training on speed, explosive power, and agility has been improved significantly.

Sáez de Villarreal E, Suarez-Arrones L, Requena B, Haff GG, Ramos Veliz R.(2014) tested to compare the effects of 6 weeks of dry land, in-water specific strength

training and plyometric training combined with a water polo (WP) training program on seven sport-specific performance parameters. Therefore, they propose preseason WP training should include a combined training program which contains dry land and in water specific strength and plyometric training in order to optimise the WP preparation for competition.

Arazi, Hamid Coetzee, Ben Asadi, Abbas (2012) examined a study on comparative effect of land- and aquatic-based plyometric training on jumping ability and agility of young basketball players. They found that the 8-week aquatic-based plyometric training program provided the same or more benefits for jumping and agility ability of young basketball players than the land-based plyometric training program of the same duration.

Yaser et. al (2008) investigates a study on the effect of aquatic and land plyometric training on physical performance and muscular enzymes in male wrestlers. They found that there was no significant difference between 2 model of plyometric training (Aquatic and Land) in performance and risk of muscle injury in male club wrestlers. Aquatic plyometrics provided the same performance enhancement benefits as land plyometrics with less muscle soreness

Stemm JD, Jacobson BH. (2007) wanted to compare vertical jump performance after land- and aquatic-based plyometric training. It was concluded that aquatic training resulted in similar training effects as land-based training, with a possible reduction in stress due to the reduction of impact afforded by the buoyancy and resistance of the water upon landing.

Martel GF, Harmer ML, Logan JM, Parker CB (2005) investigated the effects of APT on VJ and muscular strength in volleyball players. This study concludes that 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.

Robinson LE, Devor ST, Merrick MA, Buck worth J.(2004) aimed to compare changes in performance indicators (power, torque, and velocity) and muscle soreness between plyometric training on land and in water. Their study shows muscle soreness was significantly greater in the land compared to the aquatic plyometric training group at baseline and each time training intensity was increased,  $p = 0.01$ . Aquatic plyometrics provided the same performance enhancement benefits as land plyometrics with significantly less muscle soreness.

### 2.3. STUDIES ON OTHER ALLIED LITERATURE

Chtara M, Chaouachi A, Levin GT, Chaouachi M, Chamari K, Amri M, Laursen PB, (2015) conducted a study on the effect of concurrent endurance and circuit resistance training sequence on muscular strength and power development. The purpose of this study was to examine the influence of the sequence order of high-intensity endurance training and circuit training on changes in muscular strength and anaerobic power. The intersession sequence did not influence the adaptive response of muscular strength and explosive strength and power. Circuit training alone induced strength and power improvements that were significantly greater than when resistance and endurance training were combined, irrespective of the intersession sequencing.

Venkatachalapathy. R (2015) conducted a study on effect of circuit training programme on speed and agility. His study proved that was found that there was a significant improvement on speed and agility for circuit training group when compared with the control group.

Tønnessen, Espen; Shalfawi, Shafer AI; Haugen, Thomas; Enoksen, Eystein (2014) conducted a study on The Effect of 40-m Repeated Sprint Training on Maximum Sprinting speed, repeated sprint speed endurance, vertical jump, and aerobic capacity in young elite male soccer players. They found that the results of this study indicate that the repeated sprint program had a positive effect on several of the parameters tested. However, because the sample size in this study is 20 participants, the results are valid only for those who took part in this study. Therefore, we advice to use repeated sprint training similar to the one in this study only in periods where the players have no speed training included in their program. Furthermore, the participants in this study should probably trained strength, however, benefits were observed even without strength training is most likely to be caused by the training specificity.

Chatzopoulos D, Galazoulas C, Patikas D, Kotzamanidis C.(2014) conducted a study on acute effects of static and dynamic stretching on balance, agility, reaction time and movement time. They found that there was no effect of the stretching protocols on reaction time. Dynamic stretching was more effective than static stretching for increasing movement time of the upper extremities.

Miyaguchi K, Demura S, Omoya M. (2014) conducted a study on relationship between jump rope double under and sprint performance in elementary school children. They found that children who perform better in double unders are also faster during a 20-m Sprint run. This tendency may be higher in boys. Classic jump rope training, such as double unders, should be effective as elementary plyometrics for improving the sprint ability of children.

Chittibabu B and Dr. N. Akilan(2014), conducted study on effect of sports specific endurance circuit training on sprinting performance and leg explosive power of high school male basketball players during competitive. Their research show that sports

specific endurance circuit training group significantly improved sprinting performance and leg explosive power of adolescent male basketball players during competitive season.

Raja Gopal EDr. Y. Gopi Krishna (2014) conducted a study on influence of interval training, circuit training and combined training on selected skill related physical fitness variables and performance variables among football players. They concluded that there was the significant improvement in the muscular endurance and performance variables among High School football players.

Sudhakar Babu, Paul Kumar (2014) conducted a study on effect of continuous running fartlek and interval training on speed and coordination among male soccer players. The result of the study showed that there was as significantly improvement was found in speed and Coordination among the experimental group when compared with control group.

Mojtaba Brararzade Grivedehi1, Parivash Nourbakhsh1\*and Hossein Sepasil (2014) conducted a study on effects of speedy and demonstration jumping-rope training on gross motor skills. . There results showed that there are significant differences in gross motor skills and sub-tests of balance, strength and bilateral coordination in speedy and demonstration. In other hand, based on the findings of this study both Jumping-rope training program had significant effects on gross motor skills of the subjects However, the results showed that no significant difference were reported in running speed and agility between three groups. Based on the results of this study, it is recommended that jumping-rope could be used as a suitable program for the development of gross motor skills of fourth grade elementary boy students.

Zoran Milanović, Goran Sporiš, Nebojša Trajković, Nic James, and Krešimir Šamija(2013) conducted a study on the effects of a 12 week saq training programme on

agility with and without the ball among young soccer players. They found that SAQ training is an effective way of improving agility, with and without the ball, for young soccer player's and can be included in physical conditioning programmes.

Lockie RG, Murphy AJ, Schultz AB, Knight TJ, Janse de Jonge XA.(2012) conducted a study on the effects of different speed training protocols on sprint acceleration kinematics and muscle strength and power in field sport athletes. They concluded The FST group improved horizontal power as measured by a 5-bound test. The FST, PT, and RST groups all improved reactive strength index derived from a 40-cm drop jump, indicating enhanced muscle stretch-shortening capacity during rebound from impacts. The WT group increased absolute and relative strength measured by a 3-repetition maximum squat by approximately 15%. Step length was the major limiting sprint performance factor for the athletes in this study.

Lockie RG, Schultz AB, Callaghan SJ, Jeffriess MD.(2012), conducted a study on the effects of traditional and enforced stopping speed and agility training on multidirectional speed and athletic function. This study investigated the effects of a traditional speed and agility training program (TSA) and an enforced stopping program emphasizing deceleration (ESSA). Twenty college-aged team sport athletes (16 males, 4 females) were allocated into the training groups. The loading associated with stopping can increase unilateral strength. Coaches should ensure deceleration drills allow for appropriate sprint distances before stopping, and athletes do not favor 1 leg for stopping after deceleration.

Jovanovic, et, al (2011) made an attempt the effects of speed, agility, quickness training method on power performance in elite soccer players they found that the 2-way analysis of variance indicated that the leg improved significantly and in sprints, and they also improved their jumping performance in countermovement and continuous jumps

performed with legs extended. The SAQ training program appears to be an effective way of improving some segments of power performance in young soccer players during the in-season period. Soccer coaches could use this information in the process of planning in-season training. Without proper planning of the SAQ training, soccer players will most likely be confronted with decrease in power performance during in-season period.

Miyaguchi K, Demura S, Omoya M.(2011) conducted a study on relationship between jump rope double under and sprint performance in elementary schoolchildren. Finally they were found Classic jump rope training, such as double udders, should be effective as elementary plyometrics for improving the sprint ability of children.

Frank R. Noyes; Sue D. Barber-Westin, Stephanie T. Smith, and Thomas Campbell (2011) Conducted a study on a training program to improve neuromuscular indices in female high school volleyball players. They suggested that a significant improvement was found in the sit-up test and in the vertical jump test where 68% of the athletes increased their scores. In the drop-jump video test, significant increases were found in both the mean absolute knee separation distance and in the mean normalized knee separation distance, indicating improved lower limb alignment on landing. No athlete sustained an injury or developed an overuse syndrome during 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.

Chatzopoulos D, Galazoulas C, Patikas D, Kotzamanidis C(2009) made an attempt acute effects of static and dynamic stretching on balance, agility, reaction time and movement time. They suggested according to the results of the study, a DS protocol

is more appropriate than SS for activities that require balance, rapid change of running direction (agility) and movement time of the upper extremities.

Mayorga-Vega D, Viciano J, Cocca A.(2009) conducted a study on effects of a circuit training program on muscular and cardiovascular endurance and their maintenance in schoolchildren. They conclude that the circuit training program was effective to increase and maintain both muscular and cardiovascular endurance among schoolchildren. This could help physical education teachers design programs that permit students to maintain fit muscular and cardiovascular endurance levels.

Eduardo José, Manuel Janeira (2008) examined a study on effects of complex training on explosive strength in adolescent male basketball players. This study showed that more strength conditioning is needed during the sport practice season. Furthermore, we also conclude that complex training is a useful working tool for coaches, innovative in this strength-training domain, equally contributing to a better time-efficient training.

Moktar et.al. (2008) conducted a study on effect of concurrent endurance and circuit resistance training sequence on muscular strength and power development. They found that the intersession sequence did not influence the adaptive response of muscular strength and explosive strength and power. Circuit training alone induced strength and power improvements that were significantly greater than when resistance and endurance training were combined, irrespective of the intersession sequencing.

Rhea MR, Peterson MD, Lunt KT, Ayllón FN (2006) made an attempted the effectiveness of resisted jump training on the VertiMax in high school athletes. They conclude that to differ between the groups and favored the VertiMax training group. Combined with previous research with college athletes, these data show the added



effectiveness of resisted jump training on the VertiMax among athletes for the development of lower-body power.

#### **2.4. SUMMARY OF LITERATURE**

In this study 90 reviews were collected from the earlier study in connection with the present study. The collected review starts from the year 2000 to 2015. Out of 90 reviews 62 reviews were related plyometric training, 7 related to aquatic plyometric training and 21 reviews forced on the effect of other training effect.