Chapter - II

REVIEW OF RELATED LITERATURE
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The research scholar has made every possible effort to go through the literature the problem related to the literature. The scholar has gleaned through almost every source like research quarterly, journal of various kinds, periodicals, encyclopedia, relevant books and e-resources on volleyball training and the allied areas. The investigator visited various libraries to collect the literature. The related literatures were also collected from Tamil Nadu Physical Education and Sports University, Chennai, Annamali University, Department of Physical Education, Chidambram, Alagappa University College of Physical Education, Karaikudi, and Bharathidasan University, Tiruchirappalli. The literature from various databases such as Scopus database, Web of science and Shodhganga was also documented in this chapter.

2.1. STUDIES ON BATTLE ROPE TRAINING

Parasuraman & Mahadevan (2018) studied the impact of 6 weeks battle rope training on selected psychological variables among inter collegiate volleyball players. The subject divided into two equal groups of 15 each, such as experimental and control group. The experimental group participated in the battle rope training for 6 weeks, practice session for thrice a week, each section lasted 45 minutes. The collected data were analysed statistically through analyze of covariance (ANCOVA) to find the significance difference. The result of the study showed that systematic practice of 6 weeks battle rope training significance differences on selected psychological variables such as aggression and sports achievement motivation of inter collegiate volleyball players.
Parasuraman & Mahadevan (2018) examined the effect of kettle bell and battle rope training on selected physical variables among Inter collegiate volleyball players. The subjects randomly divided into three equal groups and each group consists of 15 subjects such as experimental groups and control group. The duration of the experimental period was six weeks; practice session for thrice a week, each section lasted 45 minutes and the control group did not participate in any kind of special training programme apart from the daily physical activities. The collected data were analysed statistically through analyze of covariance (ANCOVA) to find the significance difference, the result of the study showed that systematic practice of 6 weeks kettlebell and battle rope training significance differences on upper body muscular strength and core strength better than the control group in selected physical variables among inter collegiate volleyball players.

Chen, et al., (2018) examined the battle rope training enhances multiple physical fitness dimensions, including aerobic capacity, upper-body anaerobic power, upper-body and lower-body power, agility, and core muscle endurance, and shooting accuracy in basketball players. Thirty male collegiate basketball players were randomly assigned to the battle rope training and shuttle run groups. The result of the shows that battle rope training group exhibited significant improvements in aerobic capacity, upper-body anaerobic power, upper-body and lower-body power, agility, and core muscle endurance, and shooting accuracy. Battle rope training effectively improves multiple physical fitness dimensions and shooting accuracy in collegiate basketball players.

Chen, et al., (2018) examined the eight-week battle rope training improves multiple physical fitness dimensions and shooting accuracy in collegiate basketball players. Battle rope training enhances multiple physical fitness dimensions, including aerobic capacity, upper-body anaerobic power, upper-body and lower-body power, agility,
and core muscle endurance, and shooting accuracy in basketball players and compared its effects with those of regular training. Thirty male collegiate basketball players were randomly assigned to the battle rope training and shuttle run groups, each group received 8-week interval training for 3 sessions per week. The battle rope training group exhibited significant improvements in aerobic capacity, upper-body anaerobic power, upper-body power, lower-body power, core muscle endurance, and shooting accuracy.

Chen, et al., (2018) studied the effects of battle rope exercise on basketball players performance, blood lactate levels, rating of perceived exertion, and perceived muscle soreness. Fifteen well-trained Division-I male basketball players underwent the same test procedure at baseline, before battle rope exercise, and after battle rope exercise. In conclusion, battle rope exercise is physically demanding on the upper body, resulting in decreased performance in shooting accuracy and basketball chest pass speed. Battle rope exercise may be suitable for basketball training sessions in which the objective is to strengthen technical skills under fatiguing conditions.

Prakashraaj & Mohan (2017) conducted a study to find out the influence of battle rope training on selected physiological variables among male volleyball players. The subjects were randomly assigned into two groups of twelve each, such as experimental and control groups. The experimental group participated in the battle rope training for 3 days a week, one session per day and for 8 weeks each session lasted 45 minutes. The collected data were analyzed statistically through analysis of covariance (ANCOVA) to find out the significance difference. The results of the study showed that there was significant differences exist between battle rope training group and control group. And also battle rope training group showed significant improvement on vital capacity, forced vital capacity, slow vital capacity and maximum voluntary ventilation compared to control group.
Prakashraaj, et al., (2017) examined the effect of battle rope training on breath holding time, peak expiratory rate and performance among male volleyball players. The subjects were randomly assigned into two groups of sixteen each, such as experimental and control groups. The experimental group participated in the battle rope training for three days a week, one session per day and for eight weeks each session lasted forty five minutes. The collected data were analyzed statistically through analysis of covariance (ANCOVA) to find out the significance difference, if any between the groups. The results of the study showed that there was significant differences exist between battle rope training group and control group, and also battle rope high intensity group showed significant improvement on breath holding time, peak expiratory rate and performance compared to control group.

Prakashraaj, et al., (2017) studied the effect of battle rope training on grip strength, maximum strength and performance variables among male volleyball players. The subjects were randomly assigned into two groups of sixteen each, such as experimental and control groups. The experimental group participated in the battle rope training for three days a week, one session per day and for eight weeks each session lasted forty five minutes. The collected data were analyzed statistically through analysis of covariance (ANCOVA) to find out the significance difference, if any between the groups. The results of the study showed that there was significant differences exist between battle rope training group and control group, and also battle rope high intensity group showed significant improvement on grip strength, maximum strength and performance variables compared to control group.

Bobu & Palanisamy (2016) examined the impact of battle rope high intensity training on selected biochemical and physiological variables among athletes. The subject
divided into two equal groups consist of 15 each, Group I underwent Battle rope training and Group II acted as Control group. All the subjects of the two groups were tested on selected dependent variables at prior and immediately after the training programme except hemoglobin. The analysis of covariance (ANCOVA) was used to analyze the significant difference, if any among the adjusted post-test means of experimental and control group on each variable separately. The results shows that 8 weeks Battle Rope Training has significantly improved on Triglycerides, Hemoglobin, Respiratory rate, Vital capacity.

**Mohan & Kaba Rosario (2016)** conducted a study was to find out the effect of battle rope high intensity interval training on explosive power, grip strength, core strength among male volleyball players. The subjects were randomly assigned into two groups of sixteen each, such as experimental and control groups. The collected data were analyzed statistically through analysis of covariance (ANCOVA) to find out the significance difference, if any between the groups. The results of the study showed that there was significant differences exist between battle rope high intensity interval training group and control group, and also battle rope high intensity interval training group showed significant improvement on explosive power, grip strength, core strength and performance compared to control group.

**Calatayud, et al., (2015)** analyzes the muscle activity during unilateral alternating waves vs. bilateral waves of battle rope training. Twenty-one volunteers participated in a repeated-measures study on 2 different occasions. Surface electromyography signals were recorded from the anterior deltoid, external oblique, lumbar erector spine and gluteus medius during bilateral waves and unilateral waves and were normalized to the maximum voluntary isometric contraction. OBLIQ activation was significantly greater with the
unilateral waves compared with the bilateral waves, whereas LUMB signal was significantly higher with the bilateral waves compared with the unilateral waves.

Joseph, et al., (2015) examined the effects of high intensity interval-based Kettlebells and Battle Rope training on grip Strength and body composition in college Aged Adults. Subjects in both groups complete a pre-test and post-test consisting of height, weight, grip strength via handgrip dynamometers and body composition via skin fold callipers. Experimental group will undergo 5 weeks of HIIT for 3 sessions per week, consisting of a 20-minute protocol with an exercise work-to-rest ratio of 1:1 (15sec exercise; 15sec rest) alternating 2 minutes of kettle bell exercises with 2 minutes of battle rope exercises totalling four sets of each of the five exercises. The result of the study HIIT using kettle bells and battle ropes does not elicit significant changes in body composition or LHGS over a 5-week period, although there were minor improvements in these measurements for the experimental group.

Bobu, et al., (2015) studied the impact of Battle rope and Bulgarian bag high intensity interval training protocol on selected strength and physiological variables among school level athletes. They were divided into three equal groups consist of 15 each, group I underwent Battle rope training, group II underwent Bulgarian bag training. The Battle rope and Bulgarian bag training group participated in the training for 5 days in a week, one session per day and for 8 weeks each session lasted 90 minutes. The analysis of covariance (ANCOVA) was used to analyze the significant difference, if any among the adjusted post-test means of experimental and control group on each variable separately. The result of the study indicated that Battle rope and Bulgarian bag training can be used to enhance Grip strength and Vital capacity among school level athletes.
Fountaine, et al., (2015) the purpose of this study was to quantify the cardiovascular and metabolic cost from an acute 10-minute bout of rope training. Eleven physically active participants used a 15.2-m rope anchored by a post, resulting in the participant holding 7.6 m of rope in each hand. The metabolic cost was estimated from heart rate, lactate, resting O2 uptake, exercise O2 uptake, and excess post exercise O2 consumption measurements. The results of this study suggest an acute 10-minute bout of rope training in a vigorous-intensity workout, resulting in high heart rates and energy expenditure, which meet previously established threshold increase cardio respiratory fitness.

Ratamess, et al., (2015) the purpose of this study was to quantify and compare the acute metabolic responses to battling rope exercise using 2 different rest intervals. Twelve men and 10 women performed a control protocol and battling rope exercise protocols on separate days (48–72 hours) in random order while connected to a metabolic system. The BR protocol consisted of 8 sets of 30-second intervals (15 seconds of single-arm waves and 15 seconds of double-arm waves) using either a 1-minute (1RI) or 2-minute (2RI) rest interval length. A metronome was used to standardize repetition number/frequency for each exercise, that is, 15 waves for each arm for single-arm waves and 15 repetitions of double-arm waves. Blood lactate, mean protocol minute ventilation, and heart rate were significantly higher during the 1RI protocol than the 2RI protocol, and these data were significantly higher in men compared with women. These data demonstrate that BR exercise poses a significant cardiovascular and metabolic stimulus with the mean effects augmented with the use of a short rest interval.

McAuslan (2013) studied the aerobic/muscular endurance responses to a 4 week battling rope(BR) high intensity interval training(HIIT) protocol. 15 men/15
women (22±2yr) trained 3x/week, for 4 weeks. A 30 second maximal work interval (performing the exercise), alternating between the double-whip and alternating-whip exercises, separated by 60 seconds recovery for 10 work/rest rounds was used. Women used 40 foot, 1.5 inch, 20lb ropes and men used 50 foot, 1.5 inch, 25lb ropes. Following HIIT females increased VO2max (7.8%), average peak VO2 during HIIT (8.4%), pushups (36.4%), and situps (10.1%) and with no change in cadence or RPE. Males saw no change in VO2max and situps but increased pushups (11.1%), rope cadence (14%), and reduced RPE’s (13.5%). Females and males were exercising at 80% of HRmax, had greater VO2’s for double versus the alternating-whip exercises, and with peak blood lactate levels of 9.36 and 11.06mmol/L respectively. BR HIIT shows potential to improve aerobic/anaerobic parameters over 4 weeks and should include a progressive overload component.

Colin (2013) investigates the aerobic/muscular endurance responses to a 4 week battling rope, high intensity interval training protocol. A 30 second maximal work interval (performing the exercise), alternating between the double-whip and alternating-whip exercises, separated by 60 seconds recovery for 10 work/rest rounds was used. Women used 40 foot, 1.5 inch, 20lb ropes and men used 50 foot, 1.5 inch, 25lb ropes. Females and males were exercising at 80% of HRmax, had greater VO2’s for double versus the alternating-whip exercises, and with peak blood lactate levels of 9.36 and 11.06mmol/L respectively. BR HIIT shows potential to improve aerobic/anaerobic parameters over 4 weeks and should include a progressive overload component.

Ozer, el. al., (2011) examined the effects of a 12-week rope jumping and weighted rope jumping training programs on functional parameters including multi-joint coordination and proprioception, strength, endurance in adolescent female volleyball
players. Pretest posttest experimental design. Intervention: Weighted Rope Training group, Rope Training group and Controls. Main Outcome Measures: Motor coordination, proprioception, strength and endurance of the lower extremities with concentric and eccentric performances in closed kinetic chain on multi joint system assessed by the Monitorized Squat system. Absolute average error and the standard deviation for coordination and proprioception, Peak Force, Total Work, Average Power, Maximal Speed for strength and endurance tests were calculated. Kruskal-Wallis and Mann Whitney U test were utilized. Weighted rope jump group had significant decrease for the deviation results of coordination on the concentric and eccentric phases for both legs.

2.2 STUDIES ON SLACKLINE TRAINING

**Kaba Rosario (2018)** examined the effect of battle rope training on selected physical and performance variables among kabaddi players. The subjects were randomly assigned into two groups of twelve each, such as experimental and control groups. The experimental group participated in the battle training for 3 days a week, one session per day and for 6 weeks each session lasted 45 minutes. The control group maintained their daily routine activities and no special training was given. The collected data were analyzed statistically through analysis of covariance (ANCOVA) to find out the significance difference. The results of the study showed that there was significant differences exist between battle rope training group and control group. And also battle rope training group showed significant improvement on explosive power, core strength and performance variables compared to control group.

**Prakashraaj & Kaba Rosario (2018)** conducted a study was to find out the influence of slackline training on selected physical and performance variable among volleyball players. study twenty four male volleyball players have been randomly selected
from various colleges in and around Erode district in the state of Tamil Nadu, India. The subjects were randomly assigned into two groups of twelve each, such as experimental and control groups. The results of the study showed that there was significant differences exist between of slackline training group and control group. And also of slackline training group showed significant improvement on balance, leg strength and performance variables compared to control group.

Ringhof, et al., (2018) examined the Short-term slackline training improves task-specific but not general balance in female handball players. 25 female handball players participated in our study and were matched to either a slackline training or a control group. The intervention comprised 12 sessions with overall 120 minutes of slackline training using single and double slacklines. Slackline standing time and measures of dynamic and static balance were assessed before and after the intervention, as well as power and sprint-related performance parameters. Two-way repeated-measures ANOVA found a significant group × time interaction for slackline standing time, indicating larger training effects for slackline standing. For the remaining dynamic and static balance tests, no significant interactions were found. With regard to neuromuscular performance, there was a significant group × time interaction only in change of direction. In essence, the study showed that slackline training induced task-specific balance improvements without affecting general balance. This adds further evidence to the task-specificity principle of balance, although the specificity of the sample as well as the briefness of the intervention should be taken into account when generalizing our findings. Nonetheless, this study contains practical implications for team sports interventions and future balance training studies, highlighting the importance of selecting appropriate balance exercises to yield rapid and the desired training outcomes.
**Giboin (2018)** Studied the three months of slackline training elicit only task-specific improvements in balance performance. Slackline training is a challenging and motivating type of balance training, with potential usefulness. Balance performance was tested pre and post slackline training on the slackline used during the training, on a slackline with different slack, and in 5 different non-trained static and dynamic balance tasks (N training = 12, N control = 14. After the training, the training group increased their performance more than the control group in both of the slackline tasks. The long-term slackline training elicited large task-specific performance improvements but no transfer to other non-trained balance tasks. The extensive slackline training that clearly enhanced slackline performance did not improve the capability to keep balance in other tasks and thus cannot be recommended as a general fall prevention program. The significant test-retest effect seen in most of the tested tasks emphasizes the need of a control group to adequately interpret changes in performance following balance training.

**Mildren, et al., (2018)** examined the learning to balance on a slackline: Development of coordinated multi-joint synergies. Previous research has investigated synergies involved in locomotion and balance reactions; however, there is limited insight into the emergence of skilled balance control with practice of challenging tasks. We explored motor learning of tandem and single leg stance on an unstable surface-a slackline. Balance was tested in 10 naïve healthy adults at four time points: baseline, after one slackline practice session, after 1 week of practice, and 1 week following the final practice session. We recorded kinematics of the upper and lower arms bilaterally, trunk, and thigh and foot unilaterally while participants balanced in tandem and single leg stance on a slackline and narrow rigid beam (transfer task). When participants first attempted to stand on the slackline, they exhibited fast and frequent movements across all joints with actions
along the frontal plane (particularly the hip) and fell after a short period (~3 seconds). Performance improved rapidly (fewer falls), and this was accompanied by dampened trunk and foot oscillations and the development of coordinated movement patterns with a progressive emphasis on more distal upper body segments. Continuous relative phase angles between joint pairs began to cluster around either 0° (indicating in-phase movement) or 180° (indicating anti-phase movement). Participants also began to demonstrate coordinated upper body synergies and performance improvements (fewer falls) on the transfer task, while a control group (n = 10) did not exhibit similar synergies or performance improvements. Our findings describe the emergence of coordinated movement synergies involving the upper body as healthy adults learn a challenging balance task.

_Trecroci, et al., (2018)_ studied the effects of 12-week balance and slackline training programs on physical performance and perceived enjoyment scale in young soccer players. Forty-one preadolescent soccer players were assigned to two experimental groups performing traditional balance (BLT) or slackline training (SLT), and a control group. Pre-post assessment encompassed Balance Error Scoring System (BESS), Star Excursion Balance test (SEBT), sprint with 90° turns (S90), and countermovement jump (CMJ). The rate of perceived enjoyment scale (PACES) was applied at the end of the experimental period. SLT and BLT improved similarly in BESS, SEBT and S90. No changes were detected in the CMJ. Regarding PACES score, SLT presented significantly higher values than BLT. Young athletes may benefit from a motivating training approach, thus, a designed program based on slackline drills should be preferable to improve physical performance in terms of balance and change of direction ability in preadolescent soccer players.
Jager, et al., (2017) studied the compared changes in neuromuscular control between slackline training and the stabilization training elements of the FIFA 11+ programme. Twenty-five students in 2 groups performed a 12-unit training programme. The slackline training group (n = 13) exclusively trained with a slackline. The stabilization training group (n = 12) practised exercises as described in the second part of the FIFA 11+ programme. Improvements in balance were assessed using three tests for dynamic, quasi-static, and perturbed postural control. The results show that slackline training offers similar - or better - improvements in neuromuscular control as the FIFA 11+ warm-up programme. If compliance with the FIFA 11+ programme is declining, then slacklining might offer an alternative approach to reach the training goals of improved sensorimotor control.

Donath, et al., (2017) examined the effects of slackline training compared with an inactive control condition on static and dynamic balance performance parameters in children, adults and seniors. Randomized and non-randomized controlled trials that applied slackline training as an exercise intervention compared with an inactive control condition focusing on static and dynamic balance performance (perturbed and non-perturbed single leg stance) in healthy children, adults and seniors were screened for eligibility. Slackline training varied from 4 to 6 weeks with 16 ± 7 training sessions on average, ranging from 8 to 28 sessions. Slackline training mainly revealed meaningful task-specific training effects in balance performance tasks that are closely related to the training content, such as slackline standing time and dynamic standing balance.

Volery, et al., (2017) the purpose of this study was to measure alterations in sensorimotor skills and balance resulting from slackline training and conventional balance training. Forty-three physically fit subjects were randomized into three groups. Two
groups practiced three times a week for 15 minutes, including at least once supervised session, on the slackline or perform conventional balance training for 6 weeks. The control group was not allowed to perform any balance training. Before and after the intervention, the subjects underwent sensor motor and strength tests. Because CMJ had the highest intra-class correlation value, it was chosen over maximum force from leg press. For these reasons, only two out of nine measured parameters, namely MFT stability and CMJ, were analysed across groups. The only observed difference between the two groups was MFT stability, whereas the improvement of CMJ was the same. It was concluded that slacklining is partly complementary to conventional sensorimotor training.

Santos, et al., (2016) studied the effects of slackline training on the postural control system and jump performance of athletes. Participants were also tested on jump performance, provided perceived exertion (6-20 Borg scale) and local muscle perceived exertion. The latter experienced a 6-week supervised slackline training (3 sessions per week, 5-9 minutes per session). The slackline training was rated as "somewhat hard" with the quadriceps, soleus, and gastronomies being rated as the most engaged muscles. Centre of pressure parameters significantly differed before and after training only in the experimental group and only on the compliant surface (left leg: length, area, speed, deltaY, and deltaX; right leg: length, speed, Ymean, deltaY, and RMSY). Mechanical power of the legs, as measured through the 30-second maximal performance jump test, did not improve in either group. Participants underwent center of pressure (CoP) testing through three 10-second tasks (bipedal, left leg, and right leg support) over firm and compliant surfaces with eyes open. It was conclude that slacklining may be a valid cross-training tool for female basketball players.
Donath, et al., (2016) Slackline training (balancing on nylon ribbons) has been shown to improve neuromuscular performance in children and adults. Thirty-two seniors were randomly assigned in to intervention and control group. Slackline training was given for 6 weeks 3 times per week. Static and slackline standing balance performance, force development, and maximal strength of the ankle muscles were assessed before and after slackline training. Slackline training induced large task-specific improvements of slackline standing performance accompanied with reductions of lower limb and trunk muscle activity.

Donath (2013) examined the effects of slackline training (rope balancing) on balance, jump performance and muscle activity in children. Two primary-school classes’ intervention and control group. The age of the subjects ranged from 10 to 11 years. Balance (static and dynamic stance), countermovement jumps, reverse balancing on beams (3, 4.5 and 6 cm width), slackline standing (single- and double-limb) and electromyographic activity (soleus, gastrocnemius, tibialis anterior) were examined. In conclusion daily slackline training results in large slackline-specific balance improvements. Transfer effects to static and dynamic stance, reverse balancing or jumping performance seemed to be restricted.

Fusterschmied, et al., (2013) Investigated the effects of four weeks of slacklining on lower limb kinematics and muscle activity following a slip of the upright stance. Twenty-four young healthy adults participated in the study and were assigned to either training or a control group. The training group completed a 4-week training program on slacklines, while the control group received no slackline training. The result of the study shows that slacklining can improve postural control and enhance functional knee joint
stability, which seems to be induced by enhanced preparatory muscle activation of the rectus femoris.

Scharli, et al., (2013) investigated the whether the same holds true for a task that was novel for both children and adults and highly dynamic: single-legged stance on a slackline. We compared 8-year-olds with young adults and assessed the following outcome measures: time on the slackline, stability on the slackline (calculated from slackline reaction force), gaze movement, head-in-space rotation and translation, trunk-in-space rotation, and head-on-trunk rotation. Eight-year-olds fell off the slackline quicker and were generally less stable on the slackline than adults. Eight-year-olds also showed more head-in-space rotation and translation, and more gaze variability around a visual anchor point they were instructed to fixate. Trunk-in-space and head-on-trunk rotations did not differ between groups. The results imply that the lower postural stability of 8-year-olds compared to adults - as found in simple upright stance - holds true for dynamic, novel tasks in which adults lack the advantage of more practice. They also suggest that the lack of head and gaze stability constitutes an important limiting factor in children's ability to master such tasks.

Keller, et al., (2012) studied to highlight spinal adaptations going along with slackline training. Twenty-four subjects were either assigned to a training or a control group and postural control was assessed before and after the 10 training sessions. Additionally, soleus Hoffmann (H)-reflexes was elicited to evaluate changes in the excitability of the spinal reflex circuitry. Trained subjects were able to maintain balance on the slackline for at least 20 and reduced platform movements on the balance board. The H-reflexes were significantly diminished while no changes occurred in the background electromyography. The control group showed no significant changes. From a functional
point of view the reflex reduction may serve to suppress uncontrollable reflex mediated joint oscillations. As the background electromyography remained unchanged, presynaptic rather than post-synaptic mechanisms are speculated to be responsible for the changes in the Ia-afferent transmission.

Paoletti & Mahadevan (2012) examined the Balancing on a tightrope or a slackline is an example of a neuromechanical task where the whole body both drives and responds to the dynamics of the external environment, often on multiple timescales. Motivated by a range of neurophysiological observations, here we formulate a minimal model for this system and use optimal control theory to design a strategy for maintaining an upright position. Our analysis of the open and closed-loop dynamics shows the existence of an optimal rope sag where balancing requires minimal effort, consistent with qualitative observations and suggestive of strategies for optimizing balancing performance while standing and walking. Our consideration of the effects of nonlinearities, potential parameter coupling and delays on the overall performance shows that although these factors change the results quantitatively, the existence of an optimal strategy persists.

2.1. Other Topic Related Studies

Nebahat & Hakan (2018) examine the effects of rope-jump training program in physical education lessons on strength, speed and VO2 max in 10-12 year old boys. 240 male students; rope-jump group and control group. Rope-Jump group continued 10 weeks of regular physical education and sport lessons and at the same time rope jump training program exercise 3 days a week, while the control group continued physical education and sports lessons only. Body weight, body fat percentage, leg strength, 20m speed test and VO2 max test measurements were taken before and after the 10 week period in both
groups. The obtained data were evaluated in the SPSS 16 program. In the statistical analysis, t test was used in dependent and independent groups. When the measurement differences between pre-test and post-test were compared according to the groups, it was determined that weight, body fat ratio, 20m sprint, VO2 max and leg strength measurements were significantly different in favor of rope jump group. In 10-12 year old boys, rope-jump training program was the result of having a positive effect on strength, VO2 max and especially speed. As a result, the inclusion of rope-jump programs in physical education and sports lesson curriculum, and in sports branch training programs may contribute to the development of children's motor skills and accelerate the development of the children.

Colakoglu, et al., (2017) studied the effect of a 12-week rope jumping and weighted rope jumping exercise programme on body composition and strength performance in 25 female adolescent volleyball players. Group 1 was trained on the weighted rope jumping, Group 2 on rope jumping and Group 3 the control. Percentage body fat and subsequent fat free mass by Sloan and Weir’s equation, the hand grip strength by Takei Grip -D trade mark hand dynamometer, sit-ups and pushups for endurance and standing long jump, Sergeant Jump, and medicine ball javelin tests for lower and upper extremity muscular strength were applied before and after training. In this study we showed that the muscles in upper extremity, lower extremity and abdominal region of a group doing exercises for 12-week programme with weighted rope would be gained a considerable power.

Turgut, et al., (2016) examine the effects of 12-week standard versus weighted jump rope training on anaerobic power, speed, agility and flexibility in female adolescent volleyball players. Twenty-five female volleyball players were recruited to the study.
Participants were randomly separated into three study groups such as weighted jump rope training group, standard jump rope training group and control group. All participants were assessed at baseline and after 12-week training. Physical fitness was measured by using vertical jump test, 30-meter sprint test, hexagonal obstacle test, zigzag test and sit and reach test. Repeated-measures ANOVA was used for statistical analysis. Results: Comparisons showed that after 12-week training, weighted jump-rope training resulted in higher improvements in anaerobic power and agility when compared to control training; and higher improvement in agility when compared to standard jump rope training. In addition, at the end of training, speed and flexibility gains were similar in all groups. Weighted jump rope training resulted in higher improvements of anaerobic power and agility in female adolescent volleyball players. The findings of the study provide basic knowledge for developing training protocols for adolescent volleyball players.

Turgut, et al., 2016) examined the effects of 12-week standard versus weighted jump rope training on physical fitness tests including anaerobic power, speed, agility and flexibility in female adolescent volleyball players. Twenty-five subjects were randomly separated into three study weighted jump rope training, standard jump rope training and control group. All participants were assessed at baseline and after 12-week training. Physical fitness was measured by using vertical jump test, 30-meter sprint test, hexagonal obstacle test, zigzag test and sit and reach test. Repeated-measures ANOVA was used for statistical analysis. The results showed that after 12-week training, weighted jump-rope training resulted in higher improvements in anaerobic power and agility when compared to control training, and higher improvement in agility when compared to standard jump rope training. In addition, at the end of training, speed and flexibility gains were similar in all
groups. Discussion: Weighted jump rope training resulted in higher improvements of anaerobic power and agility in female adolescent volleyball players.

**Mina, et al., (2015)** studied the effects of speed and demonstration Jumping-rope training program on fine motor skills of fourth grade elementary girl students. Investigating speed response, upper limb speed and dexterity, visual motor control sub-tests served as the other goal of this study. 45 students selected by stratified random sampling as sample of this study and equally divided in two experimental (speedy and demonstration) and one control groups. Findings showed that there are significant differences between fine motor skill and sub-tests of upper limb coordination in speed and demonstration groups. In other hand, based on findings of this study both jumping rope training program had significant effect on fine motor skills of participants. However, the results showed that no significant differences reported among the mean of response speed, visual motor control in 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 fine motor skills of fourth grade elementary girl students.

**Mojtaba, et al., (2014)** examine the effects of speedy and demonstration jumping-rope training program on gross motor skills of fourth grade elementary boy students. Examining the running speed and agility, balance, strength and bilateral coordination sub-tests served as the other goals of this study. 45 students selected randomly as sample of study and equally divided in two experimental (speedy and demonstration) and one control groups. The 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.

**Sadi Partavi (2013)** conducted a study was to find out the effects of a 7-week of rope-jump training on speed, endurance and agility in middle school male students. Twenty eight male students were recruited from pre-high school and randomly were assigned into rope-jump training and control groups. The rope-jump training group underwent 7 weeks of jump rope training. The 7-wk rope jump training significantly improved cardiovascular endurance and agility compared to control group. The 50-m sprint test was also improved by in rope-jump training compared to control group. Results shows that 7 weeks rope jump training is a feasible and safe training method for improving cardiovascular endurance and agility in middle school student boys.

**Duzgun (2010)** examined the effect of a 12-wk weighted-jump-rope training program on shoulder strength. 24 healthy volleyball players age from 13 and 16 years. Group 1 took weighted-rope training, group 2 weighted-rope training, and group did not train with any specific program. The results indicate that a jump-rope training program is a good conditioning method for overhead athletes because of its potential benefits to shoulder strength.

**Irem, et al., (2010)** examined the effect of a 12-wk weighted-jump-rope training program on shoulder strength. 24 healthy volleyball players age 13–16 y. Intervention: Group 1 took weighted-rope training (n = 9), group 2 took unweighted-rope training and
group 3 did not train with any specific program. Players’ strength determined with an isokinetic dynamometer (Isomed 2000) at 180 and 60°/s on external and internal rotators, supraspinatus peak torque, and total work of the dominant shoulder. Kruskal–Wallis and Mann–Whitney U tests were used to determine the difference among the groups. The results indicate that a jump-rope training program is a good conditioning method for overhead athletes because of its potential benefits to shoulder strength.

2.4. Summary of the Literature

The review of literature supported the investigator to spot out relevant topics and variables. Further, the literature helped the investigator to frame the other suitable hypotheses leading to the problems. The latest literature also helped the investigator to support the findings pertaining to the problem. Further, the literature collected in the study would also help the research scholar to understand in the similar areas related to the study.

The research studies reviewed are from many journals available in the database/websites such as Scopus, web of science, Pub Med and other e-resources related to physical and physiological related variables etcetera that too at school and college level.

It also observed from the review of literature that only few research studies are related to Battle rope training and Salkline training. Totally, 43 related literatures were documented in this chapter and most of the literatures were related to 18 Battle rope training, 16 Salkline training and 9 other topic related studies. The review of literature helped the researcher from the methodological point of view. It was learnt that most of the research studies cited in this chapter on content analysis and experimental design as the appropriate methods for finding out the lapses and remedies.