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Effect of Six Weeks Plyometric Training on Selected Performance Variables of High School Girls Handball Players

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Abstract:
Modern handball is played on a court 40 by 20 meters with a goal in the center of each end. The goals are surrounded by a 6-meter zone where only the defending goalkeeper is allowed the goals must be scored by throwing the ball from outside the zone or while "jumping" into it. Performance at optimal levels requires high levels of Training include technical, tactical, physiological and physical skills. Identification and selection of talented soccer players are not straightforward procedures. The collected data was analyzed by applying The statistical procedure of the selected performance related variables and the mean difference between the initial and final scores of experimental and control group were compared by using independent 't' test. The pre and post data pertaining to vertical jump test, push up test, sit and reach test, shuttle run test and fifty yard dash test was collected to find out the effects of six weeks of plyometric training on selected performance related variables of high school girl's handball players. The sport is usually played indoors, but outdoor variants exist in the forms of field handball and Czech handball which were more common in the past and beach handball also called sandball. The game is quite fast and includes body contact, as the defenders try to stop the attackers from approaching the goal. Goals are scored quite frequently; teams typically score between 20 and 35 goals each.The most conclusive evidence of handball in the past came from Denmark. Holger Nielsen introduced a game and set down the rules for a game, which was the starting point of Handball. The rules were finalized in 1897, and these rules form the basis of the rules used today. The forerunner to the International Handball Federation was founded in 1928, with the IHF replacing it in 1946. The first big international competition was the 1936 Olympic Games in Berlin, followed by the first Handball World Championships being played in 1938.

1. Introduction

Sports are timeless activities; one's that human have enjoyed since at least from ancient times, as exemplified by the Greek Olympic Games. The best individual is one who is physically fit, mentally sound and sharp, emotionally balanced and socially well adjusted It is, therefore, said that: 'physical education' is an integral part of 'Total education'. Science of sports training as an independent sports science discipline is hardly thirty years old. Before this we find theories and methods of training scattered in different sports and sports science. These aspects include "a more rapid initial stretch, which generates more power in the muscle group moving in the opposite direction in the second phase of the action; and a shorter time between eccentric and concentric contractions (SSC)". Nearly all animals have different types of muscles to produce different types of reactions. Humans have three different types of muscle fibers: slow-twitch (Type I), fast-twitch A (Type IIa), and fast-twitch B (Type IIb). Type I muscle fibers are recruited for aerobic activities, so therefore contract slowly, but are very resistant to fatigue. Type II muscle fibers have both endurance and power characteristics and are recruited for long anaerobic activities. They lie in the middle of Type I and Type IIb muscle fibers as they are more fatigue resistant than Type IIb muscle fibers, but less fatigue resistant than Type I muscle fibers. Type IIb muscle fibers are recruited only for short intense activities like lifting heavy objects, sprinting and jumping. Exercising fast twitch muscles to produce quicker reactions is the basis of plyometrics. Sports medicine is another science which contributed significantly towards the development of sports training. The role of strength training for general health, good posture and for prevention of injuries is usually overlooked which in the long run can prove harmful. "Strength is the ability to overcome resistance or to act against resistance. Strength should not be

considered a product of only muscular contractions. It is, in fact, a product of voluntary muscle contraction caused by the neuromuscular system.

2. Background of the Study

The research scholar has gone through related literature available which ware relevant to the present Study. The relevant study found in the various sources which the researcher has come across are enumerated bellow

- brumitt j et al.(2015)conducted a study the lower extremity functional test (left) and lower quadrant injury in division iii athletes: a descriptive and epidemiologic report. The lower extremity functional test (left) has been used to assess readiness to return to sport after a lower extremity (le) injury. current recommendations suggest that females should complete the left in 135 s (average) (range 120 s - 150 s) and males should complete the test in 100 s (average) (range 90 s to 125 s). However, these estimates are based on limited data and may not be reflective of collegiate athletes. thus additional assessment, including normative data, of the left in sport populations is warranted. the purpose of this study was to examine left times based on descriptive information and off-season training habits in division iii (d iii) athletes. in addition, this study prospectively examined the left's ability to discriminate sport-related injury occurrence. Design: descriptive epidemiology. Setting: division Iii University. one-hundred and eighty-nine d iii collegiate athletes (106 females, 83 males) from 15 teams participated. left times, preseason questionnaire, and time-loss injuries during the sport season. Males completed the left (105 s ± 9) significantly faster than their female counterparts (117 s ± 10) ($p < 0.0001$). Female athletes who reported >3-5 hr/wk of plyometric training during the off-season had significantly slower left scores than females who performed ≤ 3 hrs/wk of plyometric training ($p = 0.03$). The overall incidence of a lower quadrant (lq) time-loss injury for female athletes was 4.5/1000 athletic exposures (aes) and 3.7/1000 aes for male athletes. Female athletes with a slower left score (≥ 118 s) experienced a higher rate of lq time-loss injuries than females with a faster left score (≤ 117 s) ($p = 0.03$).only off-season plyometric training practices seem to affect left score times among female athletes. Females with slower left scores are more likely to be injured than females with faster left scores. Injury rates in males were not influenced by performance on the left
- behrens m et al. (2015) conducted a study plyometric training improves voluntary activation and strength during isometric, concentric and eccentric contractions. this study investigated effects of plyometric training (6 weeks, 3 sessions/week) on maximum voluntary contraction (mvc) strength and neural activation of the knee extensors during isometric, concentric and eccentric contractions.twenty-seven participants were randomly assigned to the intervention or control group. maximum voluntary torques (mvt) during the different types of contraction were measured at 110° knee flexion (180°=full extension). The interpolated twitch technique was applied at the same knee joint angle during isometric, concentric and eccentric contractions to measure voluntary activation. in addition, normalized root mean square of the emg signal at mvt was calculated. the twitch torque signal induced by electrical nerve stimulation at rest was used to evaluate training-related changes at the muscle level. in addition, jump height in countermovement jump was measured. after training, mvt increased by 20nm (95% ci: 5-36nm, p=0.012), 24nm (95% ci: 9-40nm, p=0.004) and 27nm (95% ci: 7-48nm, p=0.013) for isometric, concentric and eccentric mvcs compared to controls, respectively. the strength enhancements were associated with increases in voluntary activation during isometric, concentric and eccentric mvcs by 7.8% (95% ci: 1.8-13.9%, p=0.013), 7.0% (95% ci: 0.4-13.5%, p=0.039) and 8.6% (95% ci: 3.0-14.2%, p=0.005), respectively. changes in the twitch torque signal of the resting muscle, induced by supramaximal electrical stimulation of the femoral nerve, were not observed, indicating no alterations at the muscle level, whereas jump height was increased. given the fact that the training exercises consisted of eccentric muscle actions followed by concentric contractions, it is in particular relevant that the plyometric training increased mvc strength and neural activation of the quadriceps muscle regardless of the contraction mode.

3. Methodology

In this chapter the methodology adopted for the study namely selection of subject, selection of variables, reliability of data, testers competency, instrument reliability, testers reliability, criterion measures, experimental design, orientation of the subject, collection data, test administration and administration of training program and statistical technique were presented.

3.1. Selection of Subjects

Forty (N=40) girls hand ball players who belong to Government Higher Secondary School Ernakulum, Kerala. They were equally divided (n=20) into an Experimental group and control group. The age group of the selected subjects was between 14 to 17 years.

3.2. Selection of Variables

For the purpose of the study the following performance related variables were selected Explosive strength, Strength Endurance, Flexibility, Agility, Speed. The dependent variable selected for the study was Plyometric training.

I .Instrument reliability

The instrument used for the collection of data is of international standard and their test reliability was already set.

II. Tester’s reliability

The tester’s competency was established by test retest method under the supervision of experts in the field of physical education and sports.

III. Reliability of Data

The reliability of data was censured by establishing the instrument reliability and testers competency.

3.3. Criterion Measures

3.3.1. Performance Related Variables

Sl. No	Performance Related Variables	Test Items
1	Explosive Strength	Vertical Jump
2	Strength Endurance	Push Ups
3	Flexibility	Sit and Reach
4	Agility	Shuttle Run
5	Speed	50 yard dash

Table 1

3.3.2. Dependent Variable Plyometrics

A type of training designed to improve both power and strength. It commonly takes the form of 'bounding' and 'depth jumps' in which an athlete drops down from a box lands and immediately rebounds on to the second box top. The theory behind it is that when the athlete drops down and lands on the Floor, the quadriceps muscle group undergoes an eccentric muscle contraction.

The experimental group had to undergo plyometric training for three days in a week. i.e.,on Monday, Tuesday and Friday for a period of six weeks. The plyomertic training included exercises for the whole body. The total duration of warm up plyometric exercise and cool down session was for 40-60 minutes. The intensity of the exercise was gradually increased by the use of more vigorous exercise after every two weeks. The session started with stretching exercises movements using large muscles of legs and arms. The intensity was brought down with the cool down session.

3.3.3. Orientation of the Subject

Before measuring the anthropometric the investigator had briefly explained to the subject the purpose of study and their role in the study.

3.3.4. Collection of Data

The data pertaining to selected anthropometric measurements such as height, weight, arm length, leg length, thigh girth, calf girth were collected by administrating appropriate standard tests using correct measurement procedure

3.4. Test Administration

3.4.1. Performance Related Variables

1. Shuttle run

Purpose: - To measure agility of the performer in running and changing direction.

Equipments: - marking tape, stop watch and two blocks of wood (2"*2"*4).

Administration: - two lines were drawn 30 feet away from each other. The performer stood behind the starting line and started on the signal 'go'. He had to run to the blocks kept behind the other line, pickup one, and return to the starting line and place it behind the line. He then repeated the process with the second block.

Scoring: - The time taken to complete the process was recorded.

2. 50-yard dash

Purpose: - to measure speed.

Equipments: - two stop watches or watch with a split second timer was necessary. A suitable running area to allow fifty-yard run plus extension for stopping was also required.

Administration: - it was advised that two subjects run at the same time. At the command 'to go' the starter dropped his arm so that the timer at the finish line could start timing. The subjects ran as fast as possible across the finish line.

Scoring: - the elapsed time from the starting signal until the runner crossed the finish line was measured to the nearest tenth of a second.

3. Sit and reach test

Purpose: - To measure flexibility of lower back.

Equipments: - sit and reach apparatus.

Administration: - the subject was asked to remove his shoes and sit on the floor with feet against the testing apparatus. The apparatus was placed against a wall to prevent it from sliding. The subject fully extended the leg with feet about shoulder width apart; tester held subjects knees to ensure that no one is bending the knees. His arms forward with hands placed on top of each other bending forward along the measuring tape to the maximal position and holding for one to two seconds.

Scoring: - the maximum distance reached was recorded to the nearest one by tenth of a centimeter.

4. Vertical jump
Purpose: - To measure explosive strength.
Equipments: - Board, marked chalk powder, and measuring tape.
Administration: - In the beginning a demonstration of the vertical jump, was given to a group of five to ten subjects either by the tester himself or through a trained helper. The subject was asked to stand erect facing the board, her dominant hands finger tips were marked with chalk powder and the subject is asked to rise to mark finger tips to a maximum height on the black board without lifting the heels so as to mark her maximum reach point. With the chalked hand side towards the wall a vertical jump is to be performed by the subject to make another mark at the maximal height of the jump. The subject is not allowed to run or hop. However, the subject is properly instructed to take a good jump by bending the knees and swinging the arms. The subject was given three to five trials at her will and the best performance was considered.
Scoring: - the maximum distance (among all the trials) between the reaching height and the jumping height provided the score of the test.

5. Push up
Purpose: - To measure strength endurance.
Equipments: - A bench or stool (13 inches high and 20 inches long by 14 inches wide)
Administration: - A bench or stool thirteen inches high and twenty inches long by fourteen inches wide was used. The bench was placed on a mat about six inches away from a wall so that the subject did not take a position too far forward. The subject was asked to grasp the outer edges of the bench or stool at the nearest corner and assumed a front leaning rest position with balls of her feet resting on the mat and with body and arms forming a right angle. Then the subject was asked to lower the body so that upper chest touched the near edge of the bench or stool and then to raise it to a straight arm position as many times as possible. During the test the subject's body was required to be held straight. In case, the body swayed or arched or the subject did not complete or go down to the chest bench touch position, half count was given up to maximum of four half counts. If the subject did the fifth incomplete movement, she was asked to stop the test and repeat it after a rest for two minutes. A minimum of five minutes rest was given between the pull-ups and push-ups test items.

3.4.2. Dependent Variable Plyometric Training

Sample Plyometrics training schedule					
Exercises	**Set**	**Rep**	**Rest**	**Weight**	**Miscellaneous**
Hops	02	10	30sec Approximately	N A	Alternate sets with alternate legs
Bunny Jump	02	10	30sec Approximately	NA	Alternate sets with both legs together
Squat Jump	02	10	30sec Approximately	NA	Alternate sets with both legs together
Over Head Throw	02	10	30sec Approximately	2kg	Alternate sets with both hands together
Chest Catch Throw	02	10	30sec Approximately	2kg	Alternate sets with both hands together

Table 2

3.5. Experimental Design
Purposive random group design was employed.

3.6. Statistical Technique
The data was statistically analyzed by applying Independent't' –test

4. Analysis of Data and Result of the Study
The purpose of the study was to find out the effects of six weeks of plyometric training on selected performance related variables of high school girl's handball players. The pre and post data pertaining to vertical jump test, push up test, sit and reach test, shuttle run test and fifty yard dash test was collected. The statistical analysis of data collected on the selected performance related variables have been presented in this chapter. The mean difference between the initial and final scores of experimental and control group were compared by using independent't' test.

4.1. Findings
The't' test brought out the significant mean difference between the initial and final scores of experimental and control group. The mean differences for the groups are presented in the following tables and figures. The level of significance chosen was 0.05 level of confidence throughout the study with 19 degree of freedom.

Control Factors	Pre test			Post test			t-ratio	
	N	Mean	SD	N	Mean	SD	Pre	Post
Experimental	20	12.44	2.69	20	26.15	4.85	4.351	14.070*
Control	20	9.05	2.21	20	9.0	2.47		

Table 3:'t'-Ratio of Experimental and Control Group on Vertical Jump
**Significant at the 0.05 Level of Confidence*

The above table 3 indicates that, there was a significant difference between the pre and post test performance on vertical jump, since the calculated 't' value of 14.07 is higher than tabulated 't' value of 2.093 at 0.05 level of significance with 19 degree of freedom. In the case of control group there was no significant difference.

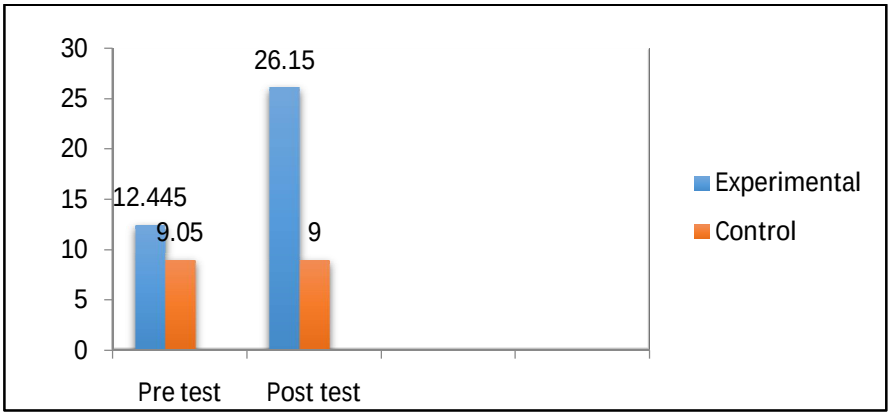

Figure 1: Illustration of Pre and Post Mean Score of Vertical Jump

Control Factors	Pre test			Post test			t-ratio	
	N	Mean	SD	N	Mean	SD	Pre	Post
Experimental	20	21.3	8.46	20	29.80	5.94	1.367	3.306*
Control	20	24.5	6.16	20	23.75	5.62		

Table 4: t-ratio of Experimental and Control Group on Push UPS
**Significant at the 0.05 Level of Confidence*

The above table 4 indicates that, there was a significant difference between the pre and post test performance on pushups, since the calculated't' value of 3.306 is higher than tabulated 't' value of 2.093 at 0.05 level of significance with 19 degree of freedom. In the case of control group there was no significant difference.

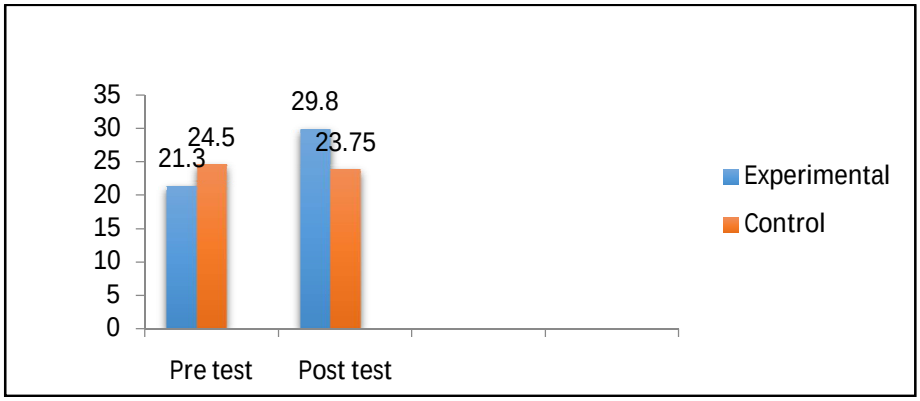

Figure 2: Illustration of Pre and Post Score of Push Up
**Significant at the 0.05 level of confidence*

The above table 5 indicates that, there was a significant difference between the pre and post test performance on sit and reach, since the calculated't' value of 7.079 is higher than tabulated 't' value of 2.093 at 0.05 level of significance with 19 degree of freedom. In the case of control group there was no significant difference.

Control Factors	Pre test			Post test			t-ratio	
	N	Mean	SD	N	Mean	SD	Pre	Post
Experimental	20	22.25	4.82	20	26.05	4.74	3.768	7.079*
Control	20	16.75	4.39	20	16.35	3.88		

Table 5: T-Ratio of Experimental and Control Group on Sit & Reach

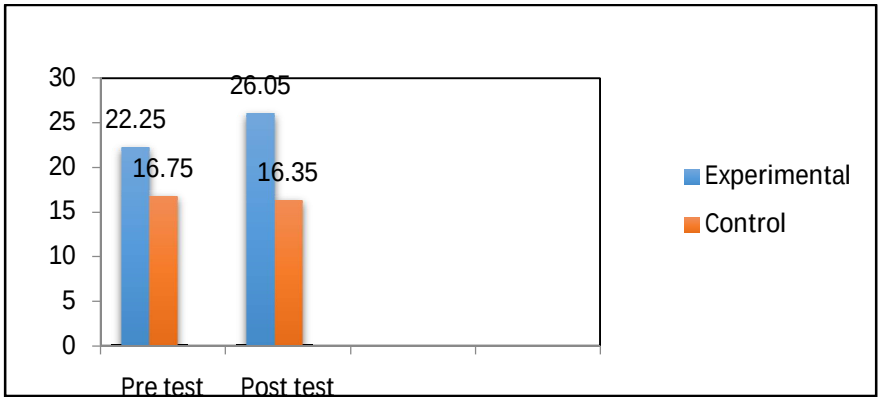

Figure 3: Illustration of Pre and Post Mean Score of Sit & Reach

Control Factors	Pre test			Post test			t-ratio	
	N	Mean	SD	N	Mean	SD	Pre	Post
Experimental	20	12.58	.51	20	13.47	.65	.787	2.328*
Control	20	12.79	1.07	20	12.79	1.12		

Table 6: t-Ratio of Experimental and Control Group on Shuttle Run
**Significant At the 0.05 Level of Confidence*

The above table 6 indicates that, there was a significant difference between the pre and post test performance on shuttle run, since the calculated‘t’ value of 2.328 is higher than tabulated ‘t’ value of 2.093 at 0.05 level of significance with 19 degree of freedom. In the case of control group there was no significant difference.

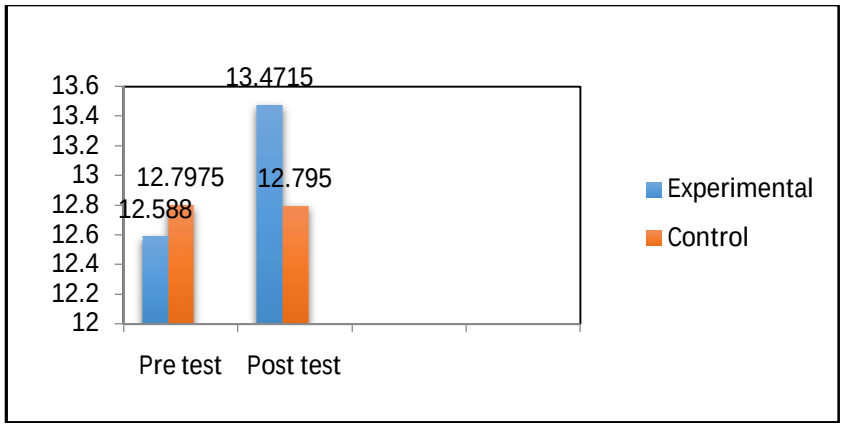

Figure 4: Illustration of Pre and Post Mean Score of Shuttle Run

Control Factors	Pre test			Post test			t-ratio	
	N	Mean	SD	N	Mean	SD	Pre	Post
Experimental	20	8.94	.66	20	9.17	.77	.271	3.197*
Control	20	8.89	.53	20	8.51	.50		

Table 7: T-Ratio of Experimental and Control Group on 50 Yard Dash
**Significant at the 0.05 Level of Confidence*

The above table 7 indicates that, there was a significant difference between the pre and post test performance on 50 yard dash, since the calculated‘t’ value of 3.197 is higher than tabulated ‘t’ value of 2.093 at 0.05 level of significance with 19 degree of freedom. In the case of control group there was no significant difference.

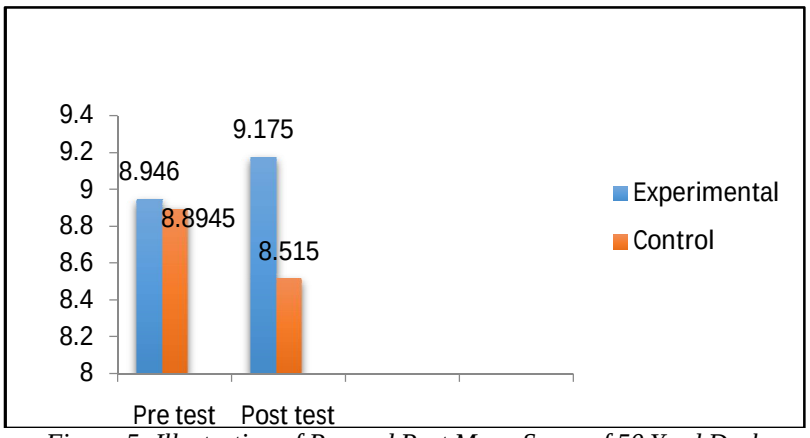

Figure 5: Illustration of Pre and Post Mean Score of 50 Yard Dash

4.2. Discussion on Findings

Handball is a team game which requires a balance of all fitness quality. All the subjects of the experimental groups had undergone six weeks of plyometric training for seventy minutes, three days per a week. From the statistical analysis it is evident that in the case of performance related variables such as explosive strength, strength endurance, flexibility, agility and speed significant changes were noticed after six week of plyometric training. The probable reason for the change in explosive strength and strength endurance could be attributed to the fact that the training for the subjects was comparatively new and the nature of the game especially in explosive situations required the players to go for vigorous movements. The improvement in speed is relative to the improvement of explosive strength since for the development of speed the strength quality which needs to be trained and improved is explosive strength. The improvement shown in flexibility and agility two of the most related fitness variables could be related to the way the game is played with sudden spurts of attack followed by slow defense.

4.3. Discussion on Hypothesis

On the basis of the findings of the study the hypothesis stated that there will be a significant effect of six weeks plyometric training on selected performance related variables of high school girls handball players is accepted.

5. Summary, Conclusion and Recommendations

5.1. Summary

The purpose of the study was to determine the effect of six weeks plyometric training programme on selected performance related variables, such as explosive strength, strength endurance, flexibility, agility and speed in high school female handball players.

The subjects of this study were forty female between the ranges of 14-17 years selected from Government Higher Secondary School Vayakkara. The subjects were randomly assigned to an experimental group and control group.

The experimental group participated in plyometric training programme three days in a week for a period of six weeks. The control group did not participate in any sort of training programme during the same period.

All the subjects were tested on the performance related variables such as explosive strength, strength endurance, flexibility, agility and speed before and after six weeks of plyometric training programme.

Explosive strength was measured by vertical jump test recorded in centimeters. Strength endurance was measured by push up test recorded in maximum number within one minute. Flexibility was measured by sit and reach test recorded to maximum reach in cm. Agility was measured by shuttle run test recorded in seconds. Speed was measured by 50 yard dash test recorded in seconds.

The data pertaining to performance related variables were analyzed by independent- t test to determine the difference between initial and final mean for experimental and control groups. The level of significant chosen was 0.05 levels.

In experimental group, significant different were seen in explosive strength, strength endurance, flexibility, agility and speed.

In the case of control group there were no changes in their selected performance related variables for the same period.

5.2. Conclusion

The results of the study permit the following conclusions;

Participation in six weeks plyometric training programme resulted in improvement of Explosive strength of high school female handball players.

Participation in six weeks plyometric training programme resulted in improvement of strength endurance of high school female handball players.

Participation in six weeks plyometric training programme resulted in improvement of flexibility of high school female handball players.

Participation in six weeks plyometric training programme resulted in improvement of agility of high school female handball players.

Participation in six weeks plyometric training programme resulted in improvement of speed of high school female handball players.

5.3. Recommendations

Awareness should be given to school students regarding the benefits of plyometric training.
Plyometric training should be incorporated in the fitness training programme for the students to develop performance related physical fitness.
Similar study will be undertaken for a longer duration of training and increasing the intensity.
Similar study will be undertaken by involving other types of plyometric exercises in training schedule.
Similar study will be undertaken with different age group and sex other than one as selected in this study.

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