Chapter - III

........................ METHODOLOGY
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METHODOLOGY

Methodology refers to the way the study is to be conducted. It refers to the study design through which validity of results is to be established Herman (1988).

In this chapter the procedure followed and methods applied in selection of subjects, selection of variables, selection of tests, instrument reliability, competency of the tester, reliability of the data, orientation of subjects, pilot study, training program, load dynamics, test administration, experimental design and statistical techniques applied for the analysis of data.

SELECTION OF SUBJECTS

The purpose of the study was to find out the effect of resistance training and endurance training in series and parallel on selected physical and physiological variables among women. To achieve these purpose forty five (N=45) women students were selected randomly from K.V.R. College, Nandigama, Krishna Dist, Andhra Pradesh, India. Their age is between 19 and 22 years. The subjects were successfully completed the minimum strength requirement test recommended by Voight and Draovitch (1991), Which consisted of five push-ups, five squat thrust, standing long jump and skipping rope for thirty seconds. The subjects were randomly divided into three groups and each group contained fifteen (n=15) subjects. Group I underwent Resistance training and Endurance training in series, group II underwent Resistance training and Endurance training in parallel and group III acted as control. The subjects were free to withdraw their consent in case they feel any difficulty during experiment and testing period. However, there were no dropouts in the study and all the volunteered subjects cooperated well throughout the period of experimentation. A written informed consent has been taken from the subjects.
SELECTION OF VARIABLES

The investigator has gone through the available literature and had discussions with various experts and his research supervisor before selecting variables. The available technique for the purpose of analysis, feasibility, reliability of the procedure and the outcome were extensively taken care of before finding the variables. After analyzing the various factors associated with the present study, the following most ideal variables were chosen to be tested during the study.

INDEPENDENT VARIABLES

Though many methods prevail to develop physical and physiological parameters, the role of resistance training (RT) and endurance training (ET) in series and parallels is an undisputed one. Previously many researchers have been carried out the research in this area, but still the bone of extension is about the series and parallel type and the duration to get benefits. Most of the Resistance Training and Endurance Training studies had been carried out in foreign countries by using the sophisticated equipment and devices available there. It is fact that hardly few explorations have been made in India in the area of Resistance Training and Endurance Training through series and parallel and their effects on Physical and Physiological parameters.

In this context the researcher is emphasized to attempt to analyze the effects of two training methods through the medium of series and parallel on physical and physiological parameters as given below.

1. Resistance training and endurance training in series.
2. Resistance training and endurance in parallel.

CRITERION VARIABLES

The efficacy in physical and physiological systems are the key to success in competitive sports. Each sports has its specific requirements of physical and physiological components for top class performance. Hence, the following criterion variables were selected under the head of physical and physiological variables.
Physical Variables:

a. speed
b. Explosive power (Horizontal)

c. Cardio Respiratory Endurance

Physiological Variables:

a. Heart rate at rest (bpm)
b. Resting Respiratory Rate (No/min)
c. Systolic blood pressure at rest (mm/Hg)
d. Diastolic blood pressure at rest (mm/Hg)

JUSTIFICATION OF THE VARIABLES SELECTED

JUSTIFICATION OF INDEPENDENT VARIABLES

The coaches and athletes who take advantage of different means and methods of trainings always change from one method of training to another best or combined two or more training methods to derive the benefits from them. Each method of resistance and endurance training is scientifically designed to achieve specific training goals. In order to achieve top class performance in this competitive sports world it is urgent need for all coaches and athletes to get knowledge of the various methods of training.

Resistance training and endurance training in series and parallel is emerging method of training and very few studies have been made so far to study its influence on different parts of the body. Thus resistance and endurance training through the medium of series and parallel training were considered as experimental variables in the present study.

In modern sports to meet the increasing competitive demands, the training amount is very close to the limit. Where mal adaptation replaces adaptation. Sports
and exercise science investigators often evaluate how different training regimes affect physical and physiological variables by statistical analyses of average values.

**JUSTIFICATION OF CRITERION VARIABLES**

Speed naturally increases the body’s endurance strength, making longer cardio and muscle strengthening training sessions easier to complete. Through speed the body increases its ability to store oxygen, which helps the muscles function in all forms of exercise.

The rate of force development is at the maximum for any type of muscle action is explosive power. In activities requiring high acceleration and output, explosive power training is necessary for maximum development.

In sports and games Heart Rate is increasingly used as a marker for exercise intensity. HR is the so-called “Individual anaerobic threshold (IAT)” Roecker and Horstmann et.al., (1998). Heart Rate values are widely used as anchor value for training recommendations from performance testing. Mostly Heart Rate is used as a link between laboratory testing results and regular training activity, therefore there is an existing demand for reliable information about the relationship between Heart Rate and objective exercise intensity. This applied to endurance, recreational sports in the same way.

The volume of air inspired or expired per minute, increases from approximately 6 L/min at rest to more than 100 L/min in the average sedentary adult male whom exercising. This substantial increase in ventilation is accomplished through three and five fold increases in resting respiratory rate.

Highly trained endurance athletes tend to have lower, maximum heart rate values. Their heart has been adapted to training by drastically increasing their stroke volume, so lower heart rate maximum values can provide optimal cardiac output.
According to Kovanagh (1990) a number of peripheral changes brought about exercise training. As a result blood pressure is reduced because of increased skeletal muscle vascularity and consequent drop in peripheral resistance.

**SELECTION OF TESTS**

Even though many tests are available, the investigator has selected the standardized tests, ideal for the chosen variables and subjects and most suitable for the purpose of the present study.

**TABLE-I**

**LIST OF CRITERION VARIABLES AND THEIR RESPECTIVE TESTS**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Physical Variables</th>
<th>Test/ Instrument</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Speed</td>
<td>50 metre dash</td>
<td>m/s</td>
</tr>
<tr>
<td>2.</td>
<td>Explosive Power</td>
<td>Standing broad jump</td>
<td>Centimeter</td>
</tr>
<tr>
<td>3.</td>
<td>Cardio Respiratory Endurance</td>
<td>Cooper’s 12minutes run/walk</td>
<td>Meter</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.No</td>
<td>Physiological Variables</td>
<td>Test/ Instrument</td>
<td>Units</td>
</tr>
<tr>
<td>4.</td>
<td>Heart rate at rest</td>
<td>Bio monitor</td>
<td>Bpm</td>
</tr>
<tr>
<td>5.</td>
<td>Resting Respiratory Rate</td>
<td>Manual method</td>
<td>Number/min</td>
</tr>
<tr>
<td>6.</td>
<td>Systolic blood pressure at rest</td>
<td>Non-invasive blood pressure monitor</td>
<td>mm/Hg</td>
</tr>
<tr>
<td>7.</td>
<td>Diastolic blood pressure at rest</td>
<td>Non-invasive blood pressure monitor</td>
<td>mm/Hg</td>
</tr>
</tbody>
</table>
INSTRUMENTS RELIABILITY

In the present study standard equipments such as Stop Watch (Casio India co.Pvt.ltd, 210 okhla Industrial Estate, Phase-III, New Delhi), non-invasive automatic blood pressure monitor (Microgene Diagnostic Systems Pvt.Ltd, 806 Vikram Tower, Rajendra Place, New Delhi) from the Department of Physical Education & Sports Sciences, Anatomy & Physiotherapy Lab, Yogi Vemana University, Vemanapuram, Kadapa, Y.S.R. Kadapa District, Andhra Pradesh, India and Steel tape (L.I Industries, inc, 100 Hanover Ave.#403, Ceder knolls, NJ 07927) and were used. The instruments were procured from reliable standard companies and were considered accurate enough for the purpose of the study.

COMPETENCY OF THE TESTER

The investigator took all the measurements in the study with the assistance of M.Phil scholars and experienced testing personnel in Physical Education & Sports Sciences, Andhra Pradesh, India. To ensure that the assistants of the investigator were well versed with the technique of conducting tests, they had a number of practice sessions to correct testing procedure. The tester’s reliability was established by test and re-test method.

RELIABILITY OF THE DATA

Test and re-test method was followed in order to establish reliability of data by using 10 subjects at random. All the criterion variables selected in the present study were tested twice for the subjects by the same personals under similar conditions.

The intra class co-efficient of correlation was used to find out the reliability of the data as suggested by Johnson and Nelson (1981) and the results were presented in Table-II.
TABLE-II
INTRA CLASS CO-EFFICIENT OF CORRELATION ON SELECTED DEPENDENT VARIABLES

<table>
<thead>
<tr>
<th>S.No</th>
<th>Variables</th>
<th>‘R’</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Speed</td>
<td>0.92</td>
</tr>
<tr>
<td>2</td>
<td>Explosive Power</td>
<td>0.96</td>
</tr>
<tr>
<td>3</td>
<td>Cardio Respiratory Endurance</td>
<td>0.88</td>
</tr>
<tr>
<td>4</td>
<td>Heart rate at rest</td>
<td>0.89</td>
</tr>
<tr>
<td>5</td>
<td>Resting Respiratory Rate</td>
<td>0.91</td>
</tr>
<tr>
<td>6</td>
<td>Systolic blood pressure at rest</td>
<td>0.98</td>
</tr>
<tr>
<td>7</td>
<td>Diastolic blood pressure at rest</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Significance at 0.01 level of confidence.

Table value of required for significance at 0.01 level of confidence is 0.77.

Since the obtained ‘R’ value was much greater than the required value, the data were accepted as reliable in terms of instrument, tester and the subjects.

ORIENTATION OF SUBJECTS

The investigator explained the purpose of the study and the importance of training program to the subjects and their part in the study in order to get co-operation as well as to ensure reliable data. Before the commencement of the resistance training and endurance training program several sessions were spent to familiarize the subjects with the techniques involved to execute the programmed resistance and endurance exercises. It helped them to perform the exercises perfectly and to avoid injuries. The subjects were motivated to attend the training sessions regularly for devoted practice. Further, control group was specially oriented, advised and controlled to avoid the practice of any of the specific training program till the end of the experimental period.
ASSESSMENT OF ONE REPETITION MAXIMUM (1RM)

After selecting the resistance exercises, 1 RM was found for each subject of both experimental groups for each exercise separately by increasing and decreasing the weight. 1 RM is the maximum amount of weight a person successfully lifts one time only through the full range of motion Tudor O. Bompa (1996).

PILOT STUDY

The training schedule was constructed after concluding a pilot study. For this 15 women were selected at random from the selected subjects. They underwent different physical activities as planned earlier. The researcher along with other experts assessed their physical ability. Based on the purpose, for the subjects in the pilot study the training schedule for resistance training and endurance training in series and parallel was constructed separately. However, the individual differences were taken into consideration. The basis principles of training were followed while constructing the training program.

LOAD DYNAMICS

There are two ways to express the load, one is expressed as the maximal number of times a given load can be lifted correctly without rest between lifts. The loads are characterized by 2 RM, 6 RM, 12 RM, etc. Berger R (1962). Another way of expression the load is as a percentage of the 1 RM Handsem J.W (1967), Mc Donagh and Davis (1984) has established the relationship between these two methods of describing the training load empirically, with in the range of 1-12 RM. The intensity variations in 12 weeks training for series and parallel groups are as follows.
## TABLE-III
### LOAD DYNAMICS

<table>
<thead>
<tr>
<th>weeks</th>
<th>Series Group*</th>
<th>Parallel Group**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Resistance Training</td>
<td>Endurance Training</td>
</tr>
<tr>
<td>1,2</td>
<td>60-64</td>
<td>-</td>
</tr>
<tr>
<td>3,4</td>
<td>68-72</td>
<td>-</td>
</tr>
<tr>
<td>5,6</td>
<td>76-80</td>
<td>-</td>
</tr>
<tr>
<td>7,8</td>
<td>-</td>
<td>60</td>
</tr>
<tr>
<td>9,10</td>
<td>-</td>
<td>65</td>
</tr>
<tr>
<td>11,12</td>
<td>-</td>
<td>70</td>
</tr>
</tbody>
</table>

* Strength : 4% increase per week  
* Endurance : 5% increase per week  
** Strength : 4% increase per week  
** Endurance : 2% increase per week  
(Partial recovery is given)

## TRAINING PROGRAM

During training period the two experimental groups namely series training group and parallel training group underwent their respective training program, four days for week for 12 weeks in addition to their regular physical education activities. Group I (series group) underwent resistance training only for six weeks and endurance training in the nest six weeks. Group II (parallel group) underwent resistance training and endurance training in alternative sessions. Every training session workout lasted for about 45-60 minutes including warm-up and limbering down exercise. Group III
(control group) did not participate in any specific training. However, they performed regular physical education activities.

The subjects underwent their respective program under strict supervision. All the subjects involved in the training program were questioned about their stature throughout the training period. None of them reported injuries, however, muscle soreness was reported in the early stage, but subsided later. On the basis of pilot study the initial load and their further progression was fixed for this study which is as explained in load dynamics.

Attendance was calculated for both the training groups separately by dividing total number of training sessions by the number of sessions presented. All the subjects were presented more than 98.92% of total training sessions.

**Exercise Prescription for the Training**

The following exercises were performed during training by the experimental group are given below.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Resistance Training Protocol</th>
<th>Endurance Training protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Arm pull over</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Leg curl</td>
<td>Moderate pace running, jogging program for a duration of $\bar{X} \pm S.D 3.73$ minutes per week</td>
</tr>
<tr>
<td>3.</td>
<td>Forward rowing (free weight)</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Leg extension</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Flat bench press (free weight)</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Heel raise</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Half squat</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Elevated sit-ups</td>
<td></td>
</tr>
</tbody>
</table>
ASSESSMENT OF WORKLOAD FOR ENDURANCE TRAINING

Anaerobic Endurance Training programs were planned well in advance for experimental groups, they were informed to report at 5.00 P.M. The investigator separately monitored the timings of the training schedule.

Every training session was with a preliminary exercise of warm-up with duration of 10 minutes. The warm-up session consists of (10 stretching exercises for flexibility (2) calisthenics for development of arm, shoulder and abdominal strength and (3) brief, formal activity that was similar to the actual work performed in overload phase by placing the body readiness for maximum effort.

Each training session was ended with a warm-down or cool-down phase of 10 minutes duration consists of moderate to slow phase walking. Following this, light calisthenics and then stretching exercises were performed.

The training schedules were prescribed for subjects by taking into account the mode, intensity, frequency, duration and progression of exercise as per the guidelines given by various authors.

Mode

Aerobic activities to maintain continuously and involve large muscle groups.

Intensity

Exercise intensity between 60% and 70% of target heart rate (THR) of subjects.

The target heart rates (THR 60%, 65% and 75%) to determine the intensity of workloads were calculated by adopting the Karvonen formulae cited by King and Senn Carl N. King and Mark D.Senn (1996).
60% THR = [0.60 x HRR] + RHR.

Where, 

\[
\text{HRR} = \frac{(\text{HR Max} - \text{HR rest})}{(220 - \text{age})}
\]

\[
\text{RHR} = \text{Resting heart rate}.
\]

**Frequency**

Schedule exercise two days a week

**Duration**

The subjects were performed low to moderate pace running jogging program for duration of ̅35.38 ± S.D. 3.73 minutes per week. The training program includes 10 min. warm-up phase and 10 min. cool-down phase per session along with the specified over load phase.

**Progression of Exercise**

The progressive over load principle was applied in designing the training program. Workload increments were made after every 2 weeks of training for first four weeks. Later the same load was increased for endurance training at every four weeks for experimental groups.

**COLLECTION OF DATA**

The data on Speed, Explosive power (Horizontal), Cardio Respiratory Endurance, Heart Rate at rest, Resting Respiratory Rate, Systolic Blood Pressure at rest and Diastolic Blood Pressure at rest were collected by administering 50 metre dash, standing broad jump (Horizontal), cooper’s 12 minutes run/walk, automatic bio monitor manual method respectively. Pre-test data were collected two days before the
training program and post-test data were collected two days after the training program.

TEST ADMINISTRATION

Pre-test data were collected two days before the commencement of the training program and post-test data were collected two days after the training program. The following tests were administered for selected Physical and Physiological parameters as given below.

SPEED

50 Metre Dash

**Purpose:** To measure speed.

**Facilities/Equipments:** A 50 metre course, two stop watches, pencil and paper.

**Procedure:** After a short warm-up the subject takes a position behind the starting line. Best results are obtained when two subjects runs at the same time for competitions. The starter used the command, **on your mark and ‘Go’**. The latter accompanied by a downward sweep of the arm as a signal to the timer. The subjects run across the finish line.

**Scoring:** One trail is permitted. By using the stopwatch time was taken to the nearest one tenth of a second **Harrison Clarke .H (1987).**

EXPLOSIVE POWER

Standing Broad Jump

**Purpose:** To measure the explosive power in terms of horizontal.

**Facilities/equipments:** An outdoor jumping pit, measuring steel tape mat and marking with lime powder.
Procedure: The subjects stand behind a take-off line with feet several inches apart. Before jumping the subjects dips at the knee and swings the arms forward. Indoor administration is the best accomplished by placing a tape measure on the floor at right angles to take-off line and permitted the subjects to jump along the line. Measurement can be made by extending the tape to the point of the jump.

Instructions: you must take-off from both feet simultaneously jump as long as possible and land on both feet. Try not to fall backward after the landing. You can jump further by crouching before the jump and swing your arms.

Scoring: Distance to the nearest point from the take-off line to the closest heel position. The best out of three trails were recorded.

CARDIO VASCULAR ENDURANCE

Cooper’s 12 Minutes Walk/Run

Purpose: To assess the cardio vascular endurance.

Facilities/equipments: Stop watches, whistle, score sheet and 400 meter standard track.

Procedure: The 400 metre standard track was kept with markings at every fifty metre. The subject was divided in to two groups when one group was running the designated partners from other group acted as lap scores. The subjects were instructed to run, jog and walk according to their capacity without stopping for 12 minutes. The subjects of the first group started running on the whistle and continued to run, jog or walk and covered as much as possible distance during 12 minutes period, on expiry of 12 minutes the whistle was blown to stop and then the subjects were stopped, progressing forward but the should stand on the spot where they have stopped on whistle. The partners helping as lap scores kept the record of the number of laps completed. It was counted to total distance Harrison Clark .H (1976).
HEART RATE AT REST

**Purpose:** To record the heart at rest beats per minute.

**Facilities/Equipments:** Non-invasive Automatic blood pressure monitor (Microgene Diagnostic Systems Pvt.Ltd, 806 Vikram Tower, Rajendra Place, New Delhi).

**Procedure:** Uses the oscilometric method of heart rate at rest measurement.

Heart rate at rest of each subject was recorded in the morning time between 6.00 am and 7.00am. Ten minutes before taking the heart rate the subject was asked to sit and rest himself comfortably on a chair. The investigator wraps the cuff around the arm by placing arm on a table so that the cuff will be at the level of the heart. Just press start/stop button and the cuff will start to inflate automatically. When the measurement is complete the arm cuff automatically deflates and the heart rate at rest and blood pressure systolic/diastolic are displayed.

**Score:** Beats per minutes were recorded for each subject.

RESTING RESPIRATORY RATE AT REST

**Purpose:** To record the number of respirations per minute.

**Facilities/Equipments:** Stop watch and bench.

**Procedure:** Resting respiratory rate of each of the subjects was recorded between 6.00 am and 7.00 am consistently. Before recording the resting respiratory rate the subjects were asked to remain lying on the bed. The tester then recorded the rate of respiration by counting the movements of the subject abdomen.

**Score:** Number of the respiratory rate per minute was recorded for each subject.
SYSTOLIC AND DIASTOLIC BLOOD PRESSURE AT REST

**Purpose:** To record the systolic blood pressure and diastolic blood pressure at rest of the subjects.

**Facilities/Equipment:** Non-invasive Automatic blood pressure monitor *(Microgene Diagnostic Systems Pvt.Ltd, 806 Vikram Tower, Rajendra Place, New Delhi)*

**Procedure:** Before taking SBP at rest and DBP at rest the subject was asked to sit on chair comfortably. While taking BP the subject right arm was completely made bare to make certain that clothing does not press the blood vessels. The cuff of the monitor was tied around the subject right arm, when the monitor was switched on, the cuff automatically inflated and then deflated. The SBP at rest and DBP at rest were displayed. The readings were recorded for each subject *(Lonhotz, Settles & Weiling 1990)*.

Automatic blood pressure monitor uses the oscillometric method of blood pressure measurement.

Systolic blood pressure and diastolic blood pressure of each subject was recorded in the morning time between 6.00 am and 7.00 am. Ten minutes before taking the blood pressure the subject was asked to sit and rest himself comfortably on a chair. The investigator wraps the cuff around the arm by placing arm on a table so that the cuff will be at the level of the heart. Just press start/stop button and the cuff will start to inflate automatically. When the measurement is complete the arm cuff automatically deflates and the systolic and diastolic blood pressures are displayed.

**Score:** Systolic and diastolic blood pressure was recorded for each subject separately.
EXPERIMENTAL DESIGN

The experimental design used for this study was random group design. In this study 45 (N=45) Degree College students were randomly selected from K.V.R.College, Nandigama, Krishna Dist, Andhra Pradesh, India. They were divide into three equal groups of fifteen (n=15) in each. This study consisted of two experimental variables such as resistance training and endurance training in series and resistance training and endurance training in parallel. Among the three selected groups, group I (n=15) underwent series training, group II (n=15) underwent parallel training and group III acted as control. Both the experimental groups had undergone respective training for four sessions per week for twelve weeks. The control groups were not allowed to participate in any of the training program other than their regular curriculum.

The subjects of all the three groups were tested on physical variables i.e Speed, Explosive Power (horizontal), Cardio Respiratory Endurance and Physiological variables i.e Heart Rate at rest, Resting Respiratory Rate, Systolic Blood Pressure at rest and Diastolic Blood Pressure at rest prior to and after training program.

STATISTICAL PROCEDURES

The data collected from experimental group I, group II and control group prior to and after the experimental period on selected physical and physiological parameters were statistically analyzed for significant difference if any, by employing analysis of covariance (ANCOVA).

The pre-test and post-test means of experimental group I, group II and the control group were tested for significance by applying analysis of variance (ANOVA). After eliminating the influence of pre-test, the adjusted post-test mans of experimental groups and control group were tested for significance by using analysis of covariance.
(ANCOVA). All the data were analyzed by using computer with SPSS statistical package. The level of confidence was fixed at 0.05, for significance as the number of subjects was limited and also because, the selected variables might fluctuate due to various extraneous factors as mentioned in the limitations. In addition to this Scheffe’S post-hoc test was employed, when the ‘F’ ratio of adjusted post-test means was significant to find out the paired mean difference, if any among the groups of each variable separately.