

## **CHAPTER – III**

### **METHODOLOGY**

In this chapter the selection of the subjects, selection of the variables and tests, experimental design, pilot study, criterion measures and selection of tests, reliability of data, reliability of instruments, tester's reliability of the tests, subject reliability, orientation of the subjects, administration of training programs and administration of tests, collection of data and statistical techniques adopted for the analysis of data have been described.

#### **3.1 SELECTION OF SUBJECTS**

The primary purpose of the present study was to know the how far the influence of submaximal and maximal aerobic exercise would helpful for the development of selected musculoskeletal fitness and cardiopulmonary parameters of active smokers compared to the active smokers with the intervening methods individually. To achieve the purpose of the study, One hundred and twenty two smokers were randomly selected and their age ranged between 30 to 35 years. To find out the active smokers based on the criteria that those who have smoked 5 or more cigarettes per day for at least three smoking years. For the purpose of the present study, from the above, 60 active smokers were randomly selected as subjects and they were free from major health problem and fit to undergo the experimental training as examined and certified by the physician.

### **3.2 SELECTION OF VARIABLES**

The research scholar reviewed the available scientific literature pertaining to the problem from books, journals, magazines, websites, and research papers which revealed the importance of submaximal and maximal aerobic exercise. As far as active smokers health is concerned, musculoskeletal fitness and cardiopulmonary aspects have to be considered as the major factors. Thus the investigator selected the following variables for this study.

#### **3.2.1 DEPENDENT VARIABLES**

##### **Musculoskeletal fitness**

- ❖ Muscular Strength
- ❖ Muscular Endurance
- ❖ Flexibility

##### **Cardiopulmonary Parameters**

- ❖ Resting Heart rate (RHR)
- ❖ Maximal Oxygen Uptake (VO<sub>2</sub>Max)
- ❖ Forced vital capacity (FVC)
- ❖ Forced Expiratory Volume in one second (FEV1)
- ❖ Maximal Voluntary Ventilation (MVV)

#### **3.2.2 INDEPENDENT VARIABLES**

- ❖ Group I – Submaximal Aerobic Exercise
- ❖ Group II – Maximal Aerobic Exercise
- ❖ Group III – Control Group

### **3.3 EXPERIMENTAL DESIGN**

The study was formulated as a true random group design, consisting of a pre-test and post-test. Sixty (N=60) men active smokers working in the information technology sector in Chennai city, Tamil Nadu, India were selected as subjects at random and their ages ranged from 30 to 35 years. They were randomly assigned into three equal groups of twenty subjects each. The groups were assigned as Experimental Group I acted as a submaximal aerobic exercise group, Experimental Group II acted as maximal aerobic exercise group and Group III acted as the Control Group in an equivalent manner. The selected subjects were initially tested on criterion variables used in this study and this is considered as the pre-test. After assessing the pre-test, the subjects belonging to experimental group I was treated with submaximal aerobic exercise and subjects belonging to experimental group II were treated with maximal aerobic exercise for a period 12 weeks. As far as the subjects in the group III control group were concerned, they were not given any experimental training. After completion of the treatment period, all the subjects were again tested on criterion variables and considered this as the post-test. The data collected from the experimental and control group of selected variables was to statistically analyze by paired 't' test to find out the significant differences if any between the pre and post test. Further, in order to nullify the initial mean difference the data obtained from the three groups before and after experimentation on selected dependent variables were statistically analyzed. This analysis was done mainly to

find out the significant differences, if any, by the application of Analysis of Covariance (ANCOVA). Since, three groups were involved the obtained 'F' ratio value in the adjusted post test mean was analyzed for its significance. The Scheffe's test was applied as a post hoc test to analyze the paired mean differences, if any. In all cases 0.05 levels of significance were fixed to test hypotheses.

### **3.4 PILOT STUDY**

The present study is mainly conceived with the submaximal and maximal aerobic exercise, the investigator has to determine the intensity, frequency, specificity, recovery and type of submaximal aerobic exercises and maximal aerobic exercise in order to easily accommodate the subjects into the treatments used in the present study. For this purpose the investigator has conducted the pilot study using twenty sedentary lifestyles, male who were in active smokers. They were included in treatments specifically designed for the present study of submaximal aerobic and maximal aerobic exercises. The heart rate reserve method was used to determine the training intensity. In order to fix exercise load in each exercise for all subjects the heart rate reserve method was made popular by Karvonen ( $HR_{max} = 220 - \text{age}$ ). Resting heart rate was subtracted from maximal HR to obtain the HR reserve. From the reserve heart rate 60 % was taken as the intensity. This value was added to the resting heart rate to obtain the target heart rate (THR) The target heart rate (THT) was determined as a percentage (60 %) of the HRR plus the HRrest.

### 3.5 CRITERION MEASURES AND SELECTION OF TESTS

For the purpose of the present study, the researcher had consulted with experts such as physician, physical education professionals, exercise physiologist, and health and wellbeing professionals, reviewed various literatures accessible and selected the following test items, which are standardized and appropriate for the selected variables. The criterion variables are represented in Table - I.

**TABLE - I**  
**TEST SELECTION**

<b>S.No</b>	<b>Variables</b>	<b>Tests/Equipments</b>	<b>Units</b>
<b>1</b>	Muscular strength	Grip Strength (Hand Grip Dynamometer)	Kilograms
<b>2</b>	Muscular Endurance	Sit Ups (Electronic Stop Watch)	Numbers
<b>3</b>	Flexibility	Trunk flexibility (Sit and Reach Box)	Centimeters
<b>4</b>	Maximal Oxygen Uptake	Queens College Step Test (22.25 cm Height Bench)	Ml / kg / minute
<b>5</b>	Resting Heart rate	Heart Rate Monitor (Polar)	Beats / minute
<b>6</b>	Forced Vital Capacity	Spirometer (Easy One Air)	Liters
<b>7</b>	Forced Expiratory Volume in one Second	Spirometer (Easy One Air)	Liters
<b>8</b>	Maximal Voluntary Ventilation	Spirometer (Easy One Air)	Liters per Minute

### 3.6 RELIABILITY OF DATA

The reliability of data was established by using test-retest method. To achieve this purpose, ten subjects were randomly selected and the test was administered twice after a day's gap. Care was taken to keep all testing conditions uniformly during testing and retesting. The scores recorded for the ten subjects during the test and retests were correlated using Intra Class Correlation for the different variables. The co-efficient of correlation is presented in Table – II.

**TABLE – II**

**RELIABILITY CO-EFFICIENT OF CORRELATION OF  
TEST-RETEST SCORES**

<b>S.No</b>	<b>Variables</b>	<b>Co-efficient of correlation 'r' (N=10)</b>
1	Muscular strength	96*
2	Muscular Endurance	95*
3	Flexibility	96*
4	Maximal Oxygen Uptake	94*
5	Resting Heart rate	94*
6	Forced vital capacity	92*
7	Forced Expiratory Volume in one Second	92*
8	Maximal Voluntary Ventilation	93*

\* Significant at 0.05 level

### **3.7 RELIABILITY OF INSTRUMENTS**

The instrument such as Hand Grip Dynamometer (Polar), Electronic Stop Watch (Casio), Yoga mat, Sit and reach box, 22.25 cm Height Bench, Heart Rate Monitor (Polar), Spirometer (Easy One Air), Treadmill (Technogym), Elliptical cross trainer (Octane Fitness), Stationary cycles (Technogym), were reliable and accurate enough to carry out the test procedures successively.

### **3.8 TESTER'S RELIABILITY**

To ensure the tester's reliability of the tests the investigator had a number of practice sessions in the teaching procedure and well versed in the technique of conducting the test. Tester reliability of the test was established by a test - retest process. For this purpose ten subjects were selected at random on the chosen variables, which were recorded twice under identical conditions on different occasions by the different investigator.

### **3.9 SUBJECTS RELIABILITY**

In order to get uniform results from the same subjects, they were used under similar conditions for the same test by the same tester. The test-retest method was used to find out the subjects reliability.

### **3.10 ORIENTATION TO THE SUBJECTS**

The investigator held a meeting with the subjects prior to the administration of tests. The purpose, the significance of this study

and the requirements of the testing procedure were explained to them in detail, so that there was no ambiguity in their minds, regarding the efforts required of them. All the subjects voluntarily came forward to co-operate in the testing procedures and the training to put in their best efforts in the interest of the scientific investigation and in order to enhance their own performance. The subjects were very enthusiastic and co-operative throughout the project.

### **3.11 TRAINING PROGRAMME**

During the training period the experimental groups underwent their respective training program in addition to their daily regular activities as per the schedule. Experimental group I (Submaximal Aerobic Exercise) and Experimental group II (Maximal Aerobic Exercise) group underwent their respective experimental treatment on three alternate days per week for twelve weeks. Every training session lasted for 60 to 90 minutes. The training program was scheduled in the evening 5.30 pm and 7.00 pm. The control group was not exposed to any specific training. The subjects underwent their respective program under strict supervision prior to and during every session. Subjects underwent a 10 minute warm up and 10 minutes cool-down exercises that included jogging and stretching. The experimental training programs were designed based on the resources collected from books, periodicals, e-materials and discussions with the experts.

**TABLE – III****GENERAL STRUCTURE OF TRAINING PROGRAMME**

<b>GROUPS WITH TRAINING PARTICULARS</b>	<b>TRAINING</b>
<b>Group I</b>	Submaximal Aerobic Exercise
<b>Group II</b>	Maximal Aerobic Exercise
<b>Group III</b>	Control Group
<b>Training Duration</b>	60 to 90 Minutes
<b>Training Session Per Week</b>	Three days
<b>Total Length of Training</b>	Twelve Weeks
<b>Training Load Progression</b>	Every Three Weeks

**3.11.1 SUBMAXIMAL AEROBIC EXERCISE**

The submaximal aerobic exercises were performed using treadmills, elliptical cross trainer and a stationery bicycle under the supervision of investigators. The submaximal aerobic exercise program was scheduled for three days (Monday, Wednesday and Friday) per week in the evening 5.30 pm and 7.00 pm for twelve weeks.

For the first three weeks the submaximal aerobic exercise group performed on the selected treadmill walking/jogging/running 6 percent constant inclinations with self selected speed for 61 to 65 percent intensity followed by elliptical cross trainer with self adjusted cadence and stationary cycle with self adjusted speed exercises. Each exercise the subjects performed two sets consisting of 3 minutes duration each. The recovery was allowed in between the each set to 2 minutes.

For the second three weeks the submaximal aerobic exercise group performed on the selected treadmill walking/jogging/running 6 percent constant inclinations with self selected speed for 66 to 70 percent intensity followed by elliptical cross trainer with self adjusted cadence and stationary cycle with self adjusted speed exercises. Each exercise the subjects performed two sets consisting of 3 minutes duration each. The recovery was allowed in between the each set to 2 minutes.

For the third three weeks the submaximal aerobic exercise group performed on the selected treadmill walking/jogging/running 6 percent constant inclinations with self selected speed for 71 to 75 percent intensity followed by elliptical cross trainer with self adjusted cadence and stationary cycle with self adjusted speed exercises. Each exercise the subjects performed two sets consisting of 3 minutes duration each. The recovery was allowed in between the each set to 2 minutes.

For the fourth three weeks the submaximal aerobic exercise group performed on the selected treadmill walking/jogging/running 6 percent constant inclinations with self selected speed for 76 to 80 percent intensity followed by elliptical cross trainer with self adjusted cadence and stationary cycle with self adjusted speed exercises. Each exercise the subjects performed two sets consisting of 3 minutes duration each. The recovery was allowed in between the each set to 2 minutes. The detailed submaximal aerobic exercise program and design are given in table - IV.

**TABLE – IV**  
**SUBMAXIMAL AEROBIC EXERCISE TRAINING PROGRAMME**

<b>Week</b>	<b>Name of the Exercise/ Repetition /Set /Duration/RPM</b>	<b>Intensity</b>	<b>Rest</b>
<b>I-III Week</b>	Treadmill Walking / Jogging / Running with self selected speed, gradually increase speed, constant inclination 6% for 3 minutes X 2	61-65% HRmax	2 minutes rest in between each set
	Elliptical cross trainer, self adjusted cadence for 3 minutes X 2		
	Stationary cycles, self adjusted speed for 3 minutes X 2		
<b>IV-VI Week</b>	Treadmill Walking / Jogging / Running with self selected speed, gradually increase speed, constant inclination 4% for 3 minutes X 2	66-70% HRmax	2 minutes rest in between each set
	Elliptical cross trainer, self adjusted cadence for 3 minutes X 2		
	Stationary cycles self adjusted speed for 3 minutes X 2		
<b>VII-XI Week</b>	Treadmill Walking / Jogging / Running with self selected speed, gradually increase speed, constant inclination 6% for 3 minutes X 2	71-75% HRmax	2 minutes rest in between each set
	Elliptical cross trainer, self adjusted cadence for 3 minutes X 2		
	Stationary cycles self adjusted speed for 3 minutes X 2		
<b>X-XII Week</b>	Treadmill Walking / Jogging / Running with self selected speed, gradually increase speed, constant inclination 6% for 3 minutes X 2	76-80% HRmax	2 minutes rest in between each set
	Elliptical cross trainer, self adjusted cadence for 3 minutes X 2		
	Stationary cycles self adjusted speed for 3 minutes X 2		

### **3.11.2 MAXIMAL AEROBIC EXERCISE**

The maximal aerobic exercises were performed using treadmills, elliptical cross trainer and a stationery bicycle under the supervision of investigators. The maximal aerobic exercise program was scheduled for three days (Monday, Wednesday and Friday) per week in the evening 5.30 pm and 7.00 pm for twelve weeks.

For the first three weeks the maximal aerobic exercise group performed on the selected treadmill walking/jogging/running 10 percent constant inclinations with self selected speed for 81 to 85 percent intensity followed by elliptical cross trainer with self adjusted cadence and stationary cycle with self adjusted speed exercises. Each exercise the subjects performed two sets consisting of 3 minutes duration each. The recovery was allowed in between the each set to 3 minutes.

For the second three weeks the maximal aerobic exercise group performed on the selected treadmill walking/jogging/running 10 percent constant inclinations with self selected speed for 86 to 90 percent intensity followed by elliptical cross trainer with self adjusted cadence and stationary cycle with self adjusted speed exercises. Each exercise the subjects performed two sets consisting of 3 minutes duration each. The recovery was allowed in between the each set to 3 minutes.

For the third three weeks the maximal aerobic exercise group performed on the selected treadmill walking/jogging/running 10 percent constant inclinations with self selected speed for 91 to 95 percent intensity followed by elliptical cross trainer with self adjusted cadence and stationary cycle with self adjusted speed exercises. Each exercise the subjects performed two sets consisting of 3 minutes duration each. The recovery was allowed in between the each set to 2 minutes.

For the fourth three weeks the maximal aerobic exercise group performed on the selected treadmill walking/jogging/running 10 percent constant inclinations with self selected speed for 96 to 100 percent intensity followed by elliptical cross trainer with self adjusted cadence and stationary cycle with self adjusted speed exercises. Each exercise the subjects performed two sets consisting of 3 minutes duration each. The recovery was allowed in between the each set to 3 minutes.

The detailed maximal aerobic exercise program and design are given in table - V.

TABLE – V

## MAXIMAL AEROBIC EXERCISE TRAINING PROGRAMME

Week	Name of the Exercise/ Repetition /Set /Duration/RPM	Intensity	Rests
I-III Week	Treadmill Walking / Jogging / Running with self selected speed, gradually increase speed, constant inclination 10% for 3 minutes X 2	81 to 85% HRmax	3 minutes rest in between each set
	Elliptical cross trainer, self adjusted cadence for 3 minutes X 2		
	Stationary cycles self adjusted speed for 3 minutes X 2		
IV-VI Week	Treadmill Walking / Jogging / Running with self selected speed, gradually increase speed, constant inclination 10% for 3 minutes X 2	86 to 90% HRmax	3 minutes rest in between each set
	Elliptical cross trainer, self adjusted cadence per minute for 3 minutes X 2		
	Stationary cycles self adjusted speed for 3 minutes X 2		
VII-XI Week	Treadmill Walking / Jogging / Running with self selected speed, gradually increase speed, constant inclination 10% for 3 minutes X 2	91 to 95% HRmax	3 minutes rest in between each set
	Elliptical cross trainer, self adjusted cadence per minute for 3 minutes X 2		
	Stationary cycles self adjusted speed for 3 minutes X 2		
X-XII Week	Treadmill Walking / Jogging / Running with self selected speed, gradually increase speed, constant inclination 10 % for 3 minutes X 3	96 to 100% HRmax	3 minutes rest in between each set
	Elliptical cross trainer, self adjusted cadence per minute for 3 minutes X 2		
	Stationary cycles self adjusted speed for 3 minutes X 2		

### **3.12 ADMINISTRATION OF TEST ON MUSCULOSKELETAL FITNESS**

#### **3.12.1 MUSCULAR STRENGTH**

##### **Purpose**

To estimate the muscular strength of the upper body

##### **Equipments**

Gymnastic Mats, Hand Grip Dynamometer

##### **Procedure**

The subject was asked to stand erect for the test. The subject holds the handgrip dynamometer parallel to the side of the body at about waist level. The forearm should be level with the thigh. The subject may flex the arm slightly. Adjust the grip bar to fit comfortably within the subject's hand. The second joint of the fingers should 'fit' under the handle of the handgrip dynamometer. Make sure that the handgrip dynamometer is set back to zero. The subject should then squeeze the handgrip dynamometer as hard as possible with care not to hold their breath (Valsalva maneuver).

##### **Scoring**

Repeat this procedure using the opposite hand. Repeat the test two more times with each hand. Take the highest of the three readings for each hand and add these two values (one from each hand) together as the measure of hand grip strength, Recorded the grip strength in kilograms **(ACSM, 2008)**.

### **3.12.2 MUSCULAR ENDURANCE**

#### **Purpose**

To measure the abdominal muscular strength of the subjects

#### **Equipments**

Gymnastic Mats, stop watch

#### **Procedure**

The subjects have lain flat on the back with knees have bent and have a foot on the floor with the heels no more than one foot from the buttocks. The knee angle has to should be no less than 90° degrees. The fingers have interlocked and have placed behind the neck with the elbows touching the floor. The feet have held securely by a partner. The subjects have curled up to a sitting position and touch the chest to, the knees.

#### **Scoring**

The score was the maximum number of sit ups completed in 60 seconds (**Morrow, et al. 2005**).

### **3.12.3 FLEXIBILITY**

#### **Purpose**

To measure the flexibility of the subjects

#### **Equipments**

Sit and reach box, score sheet

**Procedure**

The sit-and-reach apparatus should have the 25cm mark equivalent to the point where the feet touch the box. The subject, has sat barefoot with the legs fully extended with the soles of the feet has placed flat against the horizontal cross board of the apparatus, with the inner edge of the sole have placed 2cm from the scale, keeping the knees have fully extended, arms evenly stretched and palms down. The subjects have bent and reached forward (without jerking) pushing the sliding marker along the scale with the fingertips as far forward as possible. The position of maximum flexion must be held for approximately two seconds. The test has repeated twice.

**Scoring**

Record the maximum distance reached to the nearest 0.5cm (Baumgartner, 2003).

**3.13 ADMINISTRATION OF TEST ON CARDIOPULMONARY PARAMETERS****3.13.1 RESTING HEART RATE (RHR)****Purpose**

To determine the Resting heart rate (HR) of the subjects

**Equipment Required**

Stopwatch, (1/100 of a second) and score sheet

**Testing Procedure**

The subject was asked to sit and rest comfortably on a chair for 5 minutes. The pulse rate was determined at a radial artery (the frequency of pulse waves per minute propagated along the peripheral arteries is usually identical to HR). The investigator lightly pressed the index and middle finger against the radial artery in the groove on the lateral wrist. The pulse rate was counted for 30 seconds and multiplied by two to get the one minute value. The same procedure was repeated for all the subjects.

**Scoring**

The number of heartbeats in one minute was recorded as the score (**ACSM, 2008**).

**3.13.2 MAXIMAL OXYGEN UPTAKE (VO<sub>2</sub>MAX)****Purpose**

To measure of Maximal Oxygen Uptake (VO<sub>2</sub>Max)

**Equipment required**

For this test was 16.25 inches or 41.3 cm high step bench, To establish stepped cadence the metronome was set at 28 beats/min, stop watch.

**Procedure**

The subjects were allowed to practice a brief period of 5 to 10 seconds the step rhythm to adjust to the cadence of the metronome. The sequence was left up/right, up/left down/right down each element to a single metronome beat. The subjects preformed the step-

ups for exactly 3 minutes. At the end of the 3 minute exercise period the subjects remained standing for 5 seconds. Then the pulse was counted at the carotid artery for 15 seconds. This was multiplied by four to give the heart rate score in beats/minutes (bpm).

### **Scoring**

The maximum oxygen consumption in ml/kg/min was calculated according to the following equation:

$$VO_{2\max} \text{ (ml/kg/min)} = 111.33 - 0.42 \times \text{heart rate (beat per minute)}$$

**(ACSM, 2008).**

### **3.13.3 FORCED VITAL CAPACITY (FVC)**

#### **Purpose**

To measure the Forced vital capacity of the subjects

#### **Equipments & facilities required**

Spirometer and score sheet.

#### **Procedure**

The Forced vital capacity (FVC) test was performed with a Spirometer (Easy One Spirometer version 3.6, Rome, Italy). During the test, the Subject was seated at 90° of hip flexion without the posterior trunk support and with their arms relaxed and upright. The subject was instructed to perform inspires fully, and then expires all the air out of the lungs as fast as they can. Subject are often (but not always) also asked to complete the cycle by breathing in again as fast as they can. The test was carried out with three repetitions.

**Scoring**

Spirometer shows the measurement in liters per. Recorded the score for subject and taken the value into the collection of the data **(Sembulingam, 2012)**.

**3.13.4 FORCED EXPIRATORY VOLUME (FEV1)****Purpose**

To measure the forced expiratory volume in one second (FEV1) of the subjects

**Equipments & facilities required**

Spirometer and score sheet.

**Procedure**

For the measurement of FEV1 digital Spirometer (Easy One Spirometer version 3.6, Rome, Italy) was used. Subjects were asked to breathe in deeply in an upright position, then to take the mouthpiece firmly between their lips and breathe out as strongly as possible for more than two seconds. Care was taken by the subject so that the air did not escape through the nose or around the mouthpiece.

**Scoring**

The peak flow meter shows the measurement in liters. Recorded the score for subject and taken the value into the collection of the data **(Sembulingam, 2012)**.

### **3.13.5 MAXIMAL VOLUNTARY VENTILATION (MVV)**

#### **Purpose**

To measure the Maximal voluntary ventilation (MVV) of the Subject

#### **Equipments & facilities required**

Spirometer and score sheet.

#### **Procedure**

Maximal voluntary ventilation (MVV) is the largest volume that can be breathed into and out of the lungs during a 10-15-s interval with maximal voluntary effort. Maximal Voluntary Ventilation was recorded by asking the subject to breathe in and out as rapidly and deeply as possible for a 15-s interval with flow measured spirometer. After discarding the first three to five breaths, the subjects were actively encouraged to maintain the same volume and frequency by following an online display of the maneuver on a computer screen, i.e., the end-expiratory level remained relatively constant. At least two acceptable maneuvers were obtained and, after flow integration, the highest value was recorded by extrapolating the 15-s accumulated volume to 1-min.

#### **Scoring**

Spirometer shows the measurement in liters per minutes shortly liters/min. Recorded the score for subject and taken the value into the collection of the data (**Sembulingam, 2012**).

### **3.14 COLLECTION OF DATA**

The variables used in the present study were assessed from all the subjects before they have to treat with the respective treatments. It was assumed as pre-test. After completion of treatment they were tested again as it was in the pre test on all variables and assumed as post test.

### **3.15 STATISTICAL TECHNIQUES**

The data collected from the experimental and control group of selected variables were statistically analyzed by paired 't' test to find out the significant differences if any between the pre and post test. Further, in order to nullify the initial mean difference the data obtained from the three groups before and after experimentation on selected dependent variables were statistically analyzed. This analysis was done mainly to find out the significant differences, if any, by the application of Analysis of Covariance (ANCOVA). Since, three groups were involved the obtained 'F' ratio value in the adjusted post test mean was analyzed for its significance. The Scheffe's test was applied as a post hoc test to analyze the paired mean differences, if any. In all cases 0.05 levels of significance were fixed to test hypotheses.

FIGURE-1

**RESEARCH FLOW CHART SHOWING THE METHODOLOGY  
ADOPTED IN THIS STUDY**

