Chapter III

PROCEDURE

In this chapter the procedure adopted for the selection of various industrial zones and rural zone for study, selection of subjects, selection of variables, criterion measures, reliability of data, administration of tests, collection of data and procedure adopted for the sub-study, (collection of data), design of the study, administration of training and conditioning programme, statistical techniques used for analysing the data have been discussed.

Selection of Various Industrial Zones and Rural Zone for Study

Problems of environmental degradation has been with mankind since time immemorial; but a new dimension has been added to them during the century due to an ever increasing pace of industrialization. The major bye-product of which is air pollution.

To meet the increasing demand the cement industry in India is undergoing an impressive expansion and these industries due to their use of various raw materials, fuels, etc. for the production of cement, the product itself and various other bye-products have adverse impact on the local surroundings as well as on the inhabitants from their health point of view. Not only that its dependant ancillary units too have introduced a certain degree of ecological degradation. Considering all these above
the cement industrial zone was accepted as an area for study.

The East India and especially the Gangiatric West Bengal is highly familiared as jute industrial area. Champdani, Baidyabati, Telinipara the neighbouring jute industrial towns are in the district of Hooghly situated just on the western bank of river Ganga possesses a good number of jute mills. The entire complex looks like a miniature India with a cosmopolitan population, too over crowded and are striving for fresh air water and sunlight etc.

Jute mills here by their various activities to produce the finished products from raw jute produce various pollutants like highly hazardous fine dust, jute fibres, particulates and microorganisms transported by natural air flow as well as by forced ventilation by exhaust fans resulting the pollution to the local aerial environment and affecting the physiological systems and resulting various pathological conditions to the local neighbouring. Considering all these, this area was selected as an area for the study.

Owing to present oil crisis and increasing demand of energy for many folds and in our country coal being plenty and ready solution for them receiving due attention as a strategic raw material for production of energy and chemicals. Every year many new coal mines are opening and the target of production is increasing.
Dhanbad - Jharia coal field in Bihar State is the only source of prime coking coal in India and is one of the most potential area in the industrial map of the country.

Coal mines here through their various operations creating the environment polluted and creating a lot of health problems especially in the cardio-respiratory parameters.

Various operations like open cast mining, mine fires, transportation of coal and sand, conversion of low grade coking coals into soft coke by open stack burning and hard coke in behive ovens having no dust and gas cleaning devices, coal washeries and many such operations create lots of smoke and coal volatiles leave suspended particulate matter various noxious gases, SO$_2$, Hydrocarbons etc. to pollute the aerial environment over here. The various ancillary and depending units, the transportation service both by road and railways and the diesel locomotives here have contributed to the mobile pollution load All these factors have shared for the extreme climatic condition over here.

A comprehensive health and socio-economic survey in a coal mining area in Dhanbad conducted by Indian Medical Association reveals a poor state of affairs. In physical appearance about 70 per cent population appeared either sick or in poor state of health and by clinical examination 35 per cent were found to be actually suffering from either major or minor ailments
requiring medical treatment. This condition of this industrial area made interested to accept as an area for study.

Iron and steel are the most useful metal basic and key industry and is the backbone of economy of our country. Durgapur is one of the most important industrial town in India for its various industrial complexes. The integrated steel plant - Durgapur steel plant here is one of the largest steel plants in India at present. The accumulated activities of all the units present here have degraded the aerial environment here to such a degree that the scientists have indicated this industrial town as a seriously polluted one and the air pollution here has reached the saturation point and considering these conditions, this area was included in the study.

Measurements of air pollutants is not an easy task. At the same time the task of monitoring the quality of air and correlating them to health aspect of human beings is equally important. This type of situation presents a unique opportunity for the study on the impact of the aerial environmental pollution on the selected physiological variables. Keeping the views and ideas in mind pre-discussed four industrial zones viz. Durgapur Cement Factory area for cement industry. Champdani Baidya -bati, Telinipara area for jute industry. Dhanbad - Jharia coal field for coal industry, and Durgapur town for heavy and iron industry were selected for the study.
To compare the industrial pollution effect among the selected four industrial zones and to get a comparative picture of those with that of a rural zone on the selected physiological variables village Kulakash of district Hooghly of West Bengal was selected as the rural zone for the study. Kulakash is a purely rural belt with a green covering surrounding it with scattered housing and thinly populated area. This area was accepted as a relatively less polluted i.e. a non-polluted area devoid of industrial activities and hazards about hundred square mile surrounding it.

In the study the rural zone was symbolised as R, similarly the cement industrial zone as Ce, the jute industrial zone as J, the coal industrial zone as Co and heavy industrial zone as H were symbolised.

**Selection of Subjects**

Subjects for the study were from four selected industrial zones and one rural zone. In various industrial zones the subjects were so selected that they live closer to the respective industries. Subjects randomly selected were totally 1000 in number i.e. 200 from each selected zone. Subjects were of 20-25 years of age group verified from their birth certificates or school records. The subjects were residing in their respective zones at least for past ten years continuously. The subjects in each zone mostly
were from middle class families and were of middle income group. Thus, there was a homogeneity among the subjects as they were of same age group representing a class mostly of same standard in life style, food habits daily routine etc. and only difference was in their zonal distribution of residence.

Contact with the subjects in various zones were made through various clubs, organizations and welfare associations.

**Selection of Variables**

On the point of selection of variables, the thing on which much consideration was invested to include those variables which are mostly affected due to industrial pollution.

The selection of variables was done by using the following criteria.

1. Through review of all the available scientific literatures pertaining to various physiological variables and pollution effects.

2. Series of discussions were held with the supervisor regarding the importance of the chosen variables in relation to the pollution effect.

3. Feasibility in terms of availability of instruments, acceptability to the subjects as well as for the researcher and the study.
Based on above mentioned criteria, the following cardio-respiratory variables were selected.

1. Breath holding capacity (both positive and negative)
2. Vital capacity
3. Air flow rate
4. Peak expiratory flow rate
5. Resting heart rate
6. Percentage of haemoglobin in blood
7. Cardio-vascular endurance.

**Criterion Measures**

The criterion measures adopted in this study for testing the hypothesis were the following:

1. Capacity to hold the breath for both positive and negative in terms of duration in second.
2. Vital capacity in terms of litre.
3. Air flow rate in terms of litre/minute.
4. Peak expiratory flow rate in terms of litre/minute.
5. Number of heart beats per minute when in resting condition.
6. Percentage of haemoglobin (gram/100 ml. of blood).
7. Distance covered in Cooper’s 12 Minute run/walk test to the nearest 50 metre.
The reliability of data was ensured by establishing the instruments reliability and tester competency.

**Instrument Reliability**

The instruments used for the study was nose clipper, stop watches, manufactured by Krishna Watch Company, Bombay, Air flow meter of Allen and Hans Brury's Division of Glaxo, Australia, peak expiratory flow meter of Clement, Clarke International Ltd., London, wet spirometer of Technical Corporation(P) Ltd., Lucknow, Sahli's Haemometer of West Germany, all had been supplied by well known manufacturers of India and abroad and catering to the research laboratory. All the instruments used were available in Human Performance Laboratory of Lakshmibai National College of Physical Education, Gwalior, and these were accepted for the study as calibrated, accurate enough and reliable.

**Tester Competency**

For testing and measuring all the variables and for collection of data, the investigator got guidance for a number of times from his guide Dr. R.N. Dey, an expert in Exercise Physiology.

A model test of data collection was held on the selected variables on five subjects chosen at random both by the investigator
and his guide under identical conditions. The correlation coefficient of measurements of the two tests were computed and presented in Table 1.

**TABLE 1**

**TESTER COMPETENCY FOR TESTS ON THE SELECTED VARIABLES**

<table>
<thead>
<tr>
<th>Tests</th>
<th>Coefficient of Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breath Holding Capacity (Positive)</td>
<td>.88*</td>
</tr>
<tr>
<td>Breath Holding Capacity (Negative)</td>
<td>.87*</td>
</tr>
<tr>
<td>Vital Capacity</td>
<td>.92*</td>
</tr>
<tr>
<td>Air Flow Rate</td>
<td>.90*</td>
</tr>
<tr>
<td>Peak Expiratory Flow Rate</td>
<td>.88*</td>
</tr>
<tr>
<td>Resting Heart Rate</td>
<td>.94*</td>
</tr>
<tr>
<td>Percentage Haemoglobin</td>
<td>.92*</td>
</tr>
<tr>
<td>Cardio-vascular Endurance</td>
<td>.89*</td>
</tr>
</tbody>
</table>

*Significant at .01 level.

**Reliability of Tests**

To establish the reliability of tests, the data on all the selected variables from each selected zone were recorded twice under identical conditions on ten randomly selected subjects from their respective zones. The variables were measured on two different days with a gap of one day in between. The scores
thus, obtained on two occasions were correlated and 'r' values found to be significant at .01 level of confidence. Thus, the subject's reliability also was established. The 'r' values obtained are presented in Table 2.

**TABLE 2**

**RELIABILITY COEFFICIENTS OF TEST - RETEST SCORES**

<table>
<thead>
<tr>
<th>Tests</th>
<th>'r' values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breath Holding Capacity (Positive)</td>
<td>.89*</td>
</tr>
<tr>
<td>Breath Holding Capacity (Negative)</td>
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</tbody>
</table>

*Significant at .01 level.

**Collection of Data**

**Breath Holding Capacity**

**Instrument Used.**

Stop watch.

**Procedure.**

Data on breath holding capacity (both positive and negative)
of each subject was collected using a stop watch after a demonstration.

For the data on positive breath holding capacity, after a command "start" the subject in a standing erect comfortable position inhaled air as much as he could. The stop watch was on immediately after the command. The subject closed the lips so that no air can pass out or pass in. The subject kept his index raised before the mouth to indicate the breath holding time and hold the position as long as he could hold the breath. As and when the subject left the breath he made his index down and the watch was stopped immediately. The same test was conducted in the same manner after a few minutes' relaxation and the best of the two readings was recorded in seconds as his final score.

Data on negative breath holding capacity was collected after the command "start". The subject now exhaled air to his maximum possible capacity, closed his lips and kept his index raised in front of the mouth. The stop watch was on. Attention was given so that no air can pass into either through the mouth or nose. The duration to which he could hold that position was recorded in seconds and the final score was recorded as his data following the test positive breath holding capacity.
Vital Capacity

Instrument Used.

Wet Spirometer.

Procedure.

Vital capacity of each subject was measured by a wet spirometer in litres. The spirometer was equipped with a good length of rubber hose (36 to 42 inches). The spirometer was fitted with water to within one inch of the top and was placed at a height where by all subjects could stand erect at the beginning of the test. The mouthpiece was disinfected by an antiseptic solution each time after used by each subject.

The subject was asked to take a deep breath before the test, and after fullest possible inhalation the subject exhaled slowly and steadily bending forward over the hose, till all the air within his control was expelled.

Care was taken to prevent air from escaping either through the nose or around the edges of the mouth piece and was also ensured that a second breath was not taken by the subject during the test. In case of doubt the test was repeated. Care was taken to lower the can without spilling the water, each time after use.1

Air Flow Rate

Air flow rate of each subject was measured using the instrument air flow meter. The instrument has a detachable mouth piece connected to a drum with a graduated dial with readings ranging from 0 - 100. Inside the dial is an indicator with revolves when air is blown into the drum. Indicator when comes to rest at some point along the graduated dial, the reading on the dial shows the air flow rate in litre/minute. For further use the indicator is to bring at "zero" by rotating the dial.

All the instructions in connection with handling the instrument was given to the subjects and demonstration also was given. Subjects were allowed for a trial. The subject to be tested in standing position had the nose clip on. Then the subject inhaled through the mouth to the maximum capacity and then exhaled the maximum possible air by blowing out into the mouthpiece with a forceful blow. The exhaled air caused the indicator to move along the graduated dial. The value where the indicator came to rest was recorded as the air flow rate of the subject in litre/minute.

In this analysis it was used the maximum of the three efforts as his measure of air flow rate.
Peak Expiratory Flow Rate

Instrument Used.

Peak Flow Metre.

Procedure.

Peak expiratory flow rate was measured by using the Mini Wright Peak Flow meter. The instrument consists of a mouth piece, a marker and a calibrated air tube, when the air is puffed into the mouth piece the marker moves along the calibrated air tube, thus, recording the peak expiratory flow rate in litres/minute.

For the collection of data necessary instructions and a demonstration was given to the subjects. The subjects were allowed for a trial.

For collecting data the subject hold the instrument in his hand in such a way that the fingers did not obstruct any way the slot. Then the subject had the nose clip on. The subject in standing position inhaled through his mouth to his maximum capacity, the mouth piece was placed in position and then expelled the maximum possible amount of air into the mouth piece with a hard blow. This caused the marker to move up through the scale. The value where the marker came to rest was recorded as the Peak Expiratory Flow Rate in litres/minute. For further use the marker was gently pushed back to the initial position.

In this analyses it was used the maximum of the three
efforts with a gap of time in between as the measure of his Peak Expiratory Flow Rate.

The mouth piece was dis-infected each time with dettol after used by each subject.

**Resting Heart Rate**

Resting heart rate was recorded while the subject was in supine position in the morning. The subject after reporting was instructed to be in supine position for 45 minutes. Then finger tips were put on the radial artery and the pulse beats were counted for sixty seconds. Score was recorded in beats per minute.

**Haemoglobin Percentage in the Blood**

**Instruments and Chemicals Used.**

Sahli's Haemometer, Frank's needle, absolute alcohol, stop watch, and Bunsen burner.

**Procedure.**

Sahli's Haemometer was used for the detection of haemoglobin percentage in the blood. The principle of the test was Sahli's acid haematine method, when the blood was converted into acid haematin by the addition of N/10 hydrochloric acid. The detailed procedure has been given in the folder supplied by company along with the instrument.
The finger tip of the subject was sterilized by swabbing it with absolute alcohol and then the skin was pierced using the Frank's needle to make the blood come out, putting a little pressure on the finger to expel the blood which was allowed to enter into the capillary pipett by the force of gravity until the 20 cu.mm. mark was reached. Care was taken that no air bubble appeared in the tube. The blood was then blown out quantitatively into the haemometer tube on the stand, containing N/10 hydrochloric acid upto the 0.2 ml. mark, and it was properly mixed using the stirrer and the liquid turned brown in colour. It was allowed to stand for five minutes in the solution distilled water was added drop by drop, followed by proper mixing until the colour of the solution in the haemometer tube matched with the non-fading coloured glass of the haemometer stand. Then the calibration of the haemometer tube were the lower meniscus of the solution was noted down as haemoglobin percentage of the subject.

Cardio-vascular Endurance

Instruments Used.

400 m. track with eight placing marks, whistle and stop watches.

Procedure.

The performers 20 at a time stood behind the starting line with an assigned spotter behind them. With the signal 'ready - start', the subjects started run or walk as many laps as possible
around the track within 12 minutes. The spotters were maintained a count of each lap, and when the signal to stop by a hard whistle was given, they immediately ran to the spots at which their runners were at the instant the whistle was blown.

**Scoring**

The score in metres was determined by multiplying the number of completed laps time the distance of each lap plus the number of segments of an incomplete lap to the nearest 50 metres.

**Procedure for Sub-study**

The following procedures were adopted to assess the training and conditioning effect on the subjects of both industrial and rural zones. In the question of selection of subjects, the physiological status of the subjects of the cardio-respiratory variables in coal industry Dhanbad was found to be in worst most condition in comparison to other zones.

On the other hand, the subjects of the coal industrial zone were found to be more enthusiastic to undergo the training and conditioning programme, interested enough to help to examine the training and conditioning effect on them, and was very eager to strengthen their physiological status on those variables if possible by the training and conditioning programme.

Considering the above factors pertaining to feasibility and data collection, the coal industrial zone Dhanbad, Bhair was
selected for the training and conditioning zone.

For administering the training and conditioning programme 60 subjects from coal industrial zone were selected randomly from the subjects already tested and were grouped randomly in equal two groups (30 subjects in each group) one group acted as the experimental group and the other as the control group. They were tested and retested on the selected variables before and after the training and conditioning programme.

To examine and to get a comparative picture of the training and conditioning effect with that of the rural zone the programme was conducted in the rural zone following the procedure as were adopted in the industrial zone.

To test the hypothesis on the selected variables, subjects of both experimental and control groups of both industrial and rural zones were tested and retested consecutively before and after they were exposed to training and conditioning programme.

Variables, criterion measures, instruments and procedure of testing for both the experimental and control groups for both the zones were same as the main study.

**Collection of Data**

Data was collected from five zones, four industrial and one rural by administering the tests on the variables selected
for the study. The task of data collection from industrial and rural zones started in the month of March, 1992 and continued upto July, 1992.

For the pre-test data on training and conditioning effect on the selected variables respectively for both industrial and rural zones, the tests were administered to the subjects before put them to training and conditioning programme. After eight weeks of regular participation in that programme the subjects were retested to get the post test data. Data was collected initially from the industrial zone and then from the rural zone.

To ensure uniformity in data collection the subjects in all the zones were tested only during specific hours between 6.00 am. and 8.00 am. Before collection of data on the variables in each case the subjects were explained the importance and significance of tests, apparatus used, procedures of testing and data collection, overall what they had to do.

**Design of the Study**

The main study i.e. the pollution effect of various industries on the inhabitants was a status study of the subjects representing various viz. cement, jute, coal, and heavy industrial zone and one rural zone. For the design of the study the basis of selecting the subjects were their place of residence. The number of subjects from each industrial zone and the rural zone was
200 in number and totally 1000. For assessing the pollution effect on the inhabitants the selected variables were tested on the subjects initially from the four selected industrial zones and to compare those with that of a rural zone data on the same variables were collected from the rural zone also.

Experimental group design was adopted to assess the training and conditioning effect on the industrial (coal) and also from rural inhabitants for a comparison. The study on training and conditioning effect 60 subjects from each i.e. from coal industrial and rural zone were randomly selected from their respective groups where 30 subjects again selected randomly were in the experimental group and 30 subjects were in the control group. The adopted training and conditioning programme of eight weeks for the experimental groups were accepted as the treatment factor. The training and conditioning programme was prepared in consultation with the Supervisor. The programme consisted of 30 minutes of general physical conditioning for the initial two weeks so that physiological systems of the subjects were ready to undertake specific load administered to them. The training and conditioning programme from third to fifth week was of 45 minutes duration and last three weeks was of one hour duration. The details of the training and conditioning programme which was adopted is described under the heading Administration of Training.
Subjects participated in the above programme five days a week i.e. from Monday to Friday, Saturdays and Sundays were rest days. No attempt was made either to control or to motivate the subjects during their training and conditioning programme. The subjects in the control groups were instructed not to participate in any activity beyond their daily routine.

The various industrial zones and the rural zone selected for the study were not equated in any way in relation to the selected variables. Similarly the accepted variables and the selected industrial and the rural zone for conducting the training and conditioning programme were not equated in any way.

**Administration of Training**

Training and conditioning programme was conducted first in the industrial zone and then in the rural zone for eight weeks of duration, completed in three phases. Duration of phases were such - 1st phase was of two weeks duration followed by 2nd phase of three weeks duration, and the 3rd phase was of three weeks duration.

**Training Programme**

*(1st Phase of 2 Weeks Duration)*

- 5 minutes - Warming-up Exercises.
- 5 minutes - Jogging, Free hand and Stretching Exercises.
15 minutes - Continuous Running
5 minutes - Warm down activities.                      Total 30 minutes

(2nd Phase of 3 Weeks Duration)

5 minutes - Warming-up Exercises
10 minutes - Jogging, Free hand and Stretching Exercises.
25 minutes - Continuous Running
5 minutes - Warm down activities.                      Total 45 minutes

(3rd Phase of 3 Weeks Duration)

8 minutes - Warming-up Exercises
12 minutes - Jogging, Free hand and Stretching Exercises.
35 minutes - Continuous Running
5 minutes - Warm down activities.                      Total 60 minutes

Training and conditioning programme was for five days a week (Monday to Friday), Saturdays and Sundays were rest days in all the three phases.

Statistical Analysis

For evaluating the effect of pollution in various industrial inhabitants on the selected variables one way analysis of variance was computed for each variable. To find out whether there was significant differences between the paired means where F-ratio
was found to be significant, Least Significant Difference Method of Post-hoc Test was used.

To find out the effect of training and conditioning and to find out the significance of differences between pre and post test means, 't' test was employed.