Chapter III

Procedure of the Study
Chapter III

PROCEDURE OF THE STUDY

OVERVIEW

3.1 Selection of Subjects
   3.1.1 Dropped/Exclusion Criteria
3.2 Selection and Classification of Variables
3.3 Equipment Used
   3.3.1 Digital Polygraph and Transducers
   3.3.2 Hand Grip Dynamometer
   3.3.3 Improvised Manometer for Valsalva Manoeuvre Test
   3.3.4 Stethoscope and Sphygmomanometer
   3.3.5 Ice Box and Thermometer
3.4 Tester’s Competency
3.5 Reliability of Instruments
3.6 Reliability of Data
3.7 Procedure of Recording of Physiological Variables
   3.7.1 Pre-recording Procedure
   3.7.2 Autonomic Function Tests
      3.7.2.1 Recording of Resting Variables
      3.7.2.2 Recording of Reactivity Variables
         3.7.2.2.1 Lying to Standing Test
         3.7.2.2.2 Deep Breathing Test
         3.7.2.2.3 Valsalva Manoeuvre Test
         3.7.2.2.4 Hand Grip Test
         3.7.2.2.5 Cold Pressure Test
   3.7.3 Extraction and Calculation of the Selected Variables (Scoring)
      3.8.1 Autonomic Activity Variables (Extraction and Calculation)
      3.8.2 Autonomic Reactivity Variables (Extraction and Calculation)
         3.8.2.1 Parasympathetic Reactivity Variables (Extraction and Calculation)
         3.8.2.2 Sympathetic Reactivity Variables (Extraction and Calculation)
3.8 Training Schedule
3.9 Training Protocol and Training Procedure
   3.10.1 Training Protocol
   3.10.2 Training Procedure
3.11 Research Design
3.12 Statistical Analysis of the Data
CHAPTER III
PROCEDURE OF THE STUDY

In this chapter selection of subjects, selection and classification of variables, equipments used, tester’s competency, reliability of instruments, reliability of data, procedure of recording of physiological variables, extraction and calculation of the selected variables (scoring), training schedule, training protocol and training procedure, research design and statistical analysis of the data are described.

3.1. Selection of Subjects

Keeping in view the purpose of the study, a large number of sedentary females (n=244) were randomly selected from Prajapita Brahma Kumaris Ishwariya Vishwa Vidyalaya, Shiv Darshan Gyan Mandir, Jaitpur Ext., New Delhi-110044. The age of the sedentary females ranged from 35 years to 45 years. The age was calculated from the date of birth and the date of pretesting. The number of samples at pre test in experimental groups were [anulom vilom (n1)=35, kapalbhati (n2)=35, bhramari (n3)=35, agnisar (n4)=35] consisting of 140 samples. The number of samples at pre test in control groups were [anulom vilom (n1)=26, kapalbhati (n2)=26, bhramari (n3)=26, agnisar (n4)=26] consisting of 104 samples. The number of samples at post test in experimental groups were [anulom vilom (n1)=30, kapalbhati (n2)=30, bhramari (n3)=32, agnisar (n4)=30] consisting of 122 samples. The number of samples at post test in control groups were [anulom vilom (n1)=23, kapalbhati (n2)=23, bhramari (n3)=26, agnisar (n4)=25] consisting of 97 samples. Details of the sampling distribution have been documented below in the table-2.

Table -2
Details of the Sampling Distribution

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of the Group</th>
<th>Proposed Sample</th>
<th>Experimental Group Females</th>
<th>Control Group Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pretest</td>
<td>Dropped/ Excluded</td>
</tr>
<tr>
<td>1.</td>
<td>Kapalbhati</td>
<td>40</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td>2.</td>
<td>AnulomVilom</td>
<td>40</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td>3.</td>
<td>Bhramari</td>
<td>40</td>
<td>35</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>Agnisar</td>
<td>40</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>160</td>
<td>140</td>
<td>18</td>
</tr>
</tbody>
</table>
3.1.1. **Dropped / Exclusion Criteria**

The following were the reasons for dropped / exclusion:

i. Absent at the post test and/or

ii. Medical problem and/or

iii. Error in recording of data

### Table-3

**Matched Experimental and Control Groups for Anulom Vilom at Pretest**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Variable</th>
<th>Group No.</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>“t”</th>
<th>Mean Difference</th>
<th>Standard Error Difference</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>1</td>
<td>26</td>
<td>37.39</td>
<td>3.408</td>
<td>.993 (N.S)</td>
<td>-0.009</td>
<td>.925</td>
<td>.993</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>37.40</td>
<td>3.286</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>RHR</td>
<td>1</td>
<td>26</td>
<td>77.74</td>
<td>8.925</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>75.20</td>
<td>9.208</td>
<td>.318 (N.S)</td>
<td>2.539</td>
<td>2.518</td>
<td>.318</td>
</tr>
<tr>
<td>3</td>
<td>SBP</td>
<td>1</td>
<td>26</td>
<td>110.00</td>
<td>12.045</td>
<td>.336 (N.S)</td>
<td>-2.800</td>
<td>2.880</td>
<td>.336</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>112.80</td>
<td>8.938</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>DBP</td>
<td>1</td>
<td>26</td>
<td>67.04</td>
<td>13.319</td>
<td>.556 (N.S)</td>
<td>-1.757</td>
<td>2.965</td>
<td>.556</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>68.80</td>
<td>8.164</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: 1 = Control Group
2 = Experimental Group
N = Number of Samples
“t” = t Test
N.S = Not significant at 0.05 level
RHR = Resting Heart Rate (bpm)
SBP = Systolic Blood Pressure (mmHg)
DBP = Diastolic Blood Pressure (mmHg)*

The analysis in regard to “anulom vilom” group at pretest in the table- 3 reveals that there were insignificant difference at 0.05 level between the control group and experimental group pertaining to the selected matching variables namely age (t=.993), resting heart rate (t=.318), systolic blood pressure (t=.336) and diastolic blood pressure (t=.556).
Table 4
Matched Experimental and Control Groups for Kapalbhati at Pretest

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Variable</th>
<th>Group No.</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>“t”</th>
<th>Mean Difference</th>
<th>Standard Error Difference</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>1</td>
<td>26</td>
<td>38.30</td>
<td>3.795</td>
<td>-.566(N.S)</td>
<td>-.562</td>
<td>.994</td>
<td>.574</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>38.87</td>
<td>3.421</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>RHR</td>
<td>1</td>
<td>26</td>
<td>75.74</td>
<td>8.052</td>
<td>1.247(N.S)</td>
<td>2.439</td>
<td>1.955</td>
<td>.218</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>73.30</td>
<td>6.193</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SBP</td>
<td>1</td>
<td>26</td>
<td>113.22</td>
<td>16.709</td>
<td>-.118(N.S)</td>
<td>-.449</td>
<td>3.804</td>
<td>.906</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>113.67</td>
<td>10.930</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>DBP</td>
<td>1</td>
<td>26</td>
<td>70.26</td>
<td>11.091</td>
<td>.383(N.S)</td>
<td>1.128</td>
<td>2.945</td>
<td>.703</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>69.13</td>
<td>10.261</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 1 = Control Group  
2 = Experimental Group  
N = Number of Samples  
“t” = t Test  
N.S = Not significant at 0.05 level  
RHR = Resting Heart Rate (bpm)  
SBP = Systolic Blood Pressure (mmHg)  
DBP = Diastolic Blood Pressure (mmHg)

The analysis in regard to “kapalbhati” group at pretest in the table 4 reveals that there were insignificant difference at 0.05 level between control group and experimental group pertaining to the selected matching variables namely age (t= -.566), resting heart rate (t= 1.247), systolic blood pressure (t= -.118) and diastolic blood pressure (t= .383).

Table 5
Matched Experimental and Control Groups for Bhramari at Pretest

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Variable</th>
<th>Group No.</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>“t”</th>
<th>Mean Difference</th>
<th>Standard Error Difference</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>1</td>
<td>26</td>
<td>40.71</td>
<td>4.112</td>
<td>.357(N.S)</td>
<td>.396</td>
<td>1.108</td>
<td>.722</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>40.31</td>
<td>4.099</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>RHR</td>
<td>1</td>
<td>26</td>
<td>77.96</td>
<td>7.250</td>
<td>1.284(N.S)</td>
<td>2.583</td>
<td>2.012</td>
<td>.205</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>75.38</td>
<td>7.594</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SBP</td>
<td>1</td>
<td>26</td>
<td>116.83</td>
<td>24.380</td>
<td>.137(N.S)</td>
<td>.708</td>
<td>5.167</td>
<td>.891</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>116.13</td>
<td>14.032</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>DBP</td>
<td>1</td>
<td>26</td>
<td>72.67</td>
<td>17.282</td>
<td>.252(N.S)</td>
<td>.917</td>
<td>3.643</td>
<td>.802</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>71.75</td>
<td>9.768</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 1 = Control Group  
2 = Experimental Group  
N = Number of Samples  
“t” = t Test  
N.S = Not significant at 0.05 level  
RHR = Resting Heart Rate (bpm)  
SBP = Systolic Blood Pressure (mmHg)  
DBP = Diastolic Blood Pressure (mmHg)
The analysis in regard to “bhramari” group at pretest in the table- 5 reveals that there were insignificant difference at 0.05 level between the control group and experimental group pertaining to the selected matching variables namely age (t= .357), resting heart rate (t= 1.284), systolic blood pressure (t=.137) and diastolic blood pressure (t= .252).

Table-6

Matched Experimental and Control Groups for Agnisar at Pretest

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Variable</th>
<th>Group No.</th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>“t”</th>
<th>Mean Difference</th>
<th>Standard Error Difference</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td>1</td>
<td>26</td>
<td>39.12</td>
<td>3.087</td>
<td>-1.185(N.S)</td>
<td>-1.113</td>
<td>.940</td>
<td>.241</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>35</td>
<td>40.23</td>
<td>3.757</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>RHR</td>
<td>1</td>
<td>26</td>
<td>80.16</td>
<td>7.295</td>
<td>.138(N.S)</td>
<td>.293</td>
<td>.212</td>
<td>.891</td>
</tr>
<tr>
<td></td>
<td>RHR</td>
<td>2</td>
<td>35</td>
<td>79.87</td>
<td>8.283</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>SBP</td>
<td>1</td>
<td>26</td>
<td>115.44</td>
<td>23.018</td>
<td>.226(N.S)</td>
<td>1.107</td>
<td>4.905</td>
<td>.822</td>
</tr>
<tr>
<td></td>
<td>SBP</td>
<td>2</td>
<td>35</td>
<td>114.33</td>
<td>12.694</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>DBP</td>
<td>1</td>
<td>26</td>
<td>74.40</td>
<td>14.457</td>
<td>.777(N.S)</td>
<td>2.267</td>
<td>2.916</td>
<td>.440</td>
</tr>
<tr>
<td></td>
<td>DBP</td>
<td>2</td>
<td>35</td>
<td>72.13</td>
<td>6.235</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 1 = Control Group
2 = Experimental Group
N = Number of Samples
“t” = t Test
N.S = Not significant at 0.05 level
RHR = Resting Heart Rate (bpm)
SBP = Systolic Blood Pressure (mmHg)
DBP = Diastolic Blood Pressure (mmHg)

The analysis in regard to “agnisar” group at pretest in the table- 6 reveals that there were insignificant difference at 0.05 level between the control group and experimental group pertaining to the selected matching variables namely age (t= -1.185), resting heart rate (t= .138), systolic blood pressure (t=.226) and diastolic blood pressure (t= .777).

3.2. Selection and Classification of Variables

Based on review of literature, scientific practices, objectives of the study, delimitations of the study, administrative feasibility, scientific authenticity and availability of expertise following variables were selected to meet the purpose of the study.
## Chapter III

### Procedure of the Study

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Variable (Abbreviation)</th>
<th>Variable (Unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RHR</td>
<td>Resting Heart Rate (bpm)</td>
</tr>
<tr>
<td>2</td>
<td>SBP</td>
<td>Systolic Blood Pressure (bpm)</td>
</tr>
<tr>
<td>3</td>
<td>DBP</td>
<td>Diastolic Blood Pressure (bpm)</td>
</tr>
<tr>
<td>4</td>
<td>SDNN</td>
<td>Standard Deviation of all NN Intervals (ms)</td>
</tr>
<tr>
<td>5</td>
<td>SDSD</td>
<td>Standard Deviation of Differences Between Adjacent NN Intervals (ms)</td>
</tr>
<tr>
<td>6</td>
<td>RMSSD</td>
<td>The Square Root of the Mean of the Sum of the Squares of Differences Between Adjacent NN Intervals (ms)</td>
</tr>
<tr>
<td>7</td>
<td>SDANN</td>
<td>Standard Deviation of the Averages of NN Intervals in All Five Minutes Segments of the Entire Recording (ms)</td>
</tr>
<tr>
<td>8</td>
<td>LF</td>
<td>Low Frequency (Normalized Units)</td>
</tr>
<tr>
<td>9</td>
<td>HF</td>
<td>High Frequency (Normalized Units)</td>
</tr>
<tr>
<td>10</td>
<td>LF/HF Ratio</td>
<td>Low Frequency High Frequency Ratio</td>
</tr>
<tr>
<td>11</td>
<td>LF (AP)</td>
<td>Low Frequency [Absolute Power (ms²)]</td>
</tr>
<tr>
<td>12</td>
<td>HF (AP)</td>
<td>High Frequency [Absolute Power (ms²)]</td>
</tr>
<tr>
<td>13</td>
<td>TP (AP)</td>
<td>Total Power [Absolute Power (ms²)]</td>
</tr>
<tr>
<td>14</td>
<td>DBT</td>
<td>Deep Breathing Test Score [Change in Heart Rate (bpm)]</td>
</tr>
<tr>
<td>15</td>
<td>E : I Ratio</td>
<td>Expiratory Inspiratory Ratio</td>
</tr>
<tr>
<td>16</td>
<td>VM Ratio</td>
<td>Valsalva Maneouvre Ratio</td>
</tr>
<tr>
<td>17</td>
<td>HGT</td>
<td>Hand Grip Test Score (mm of Hg)</td>
</tr>
<tr>
<td>18</td>
<td>CPT</td>
<td>Cold Pressure Test Score (mm of Hg)</td>
</tr>
<tr>
<td>19</td>
<td>LST</td>
<td>Lying to Standing Test Score (mm of Hg)</td>
</tr>
<tr>
<td>20</td>
<td>NN50 Count</td>
<td>The Number of Interval Differences of Successive NN Intervals Greater than 50 ms (f)</td>
</tr>
<tr>
<td>21</td>
<td>pNN50</td>
<td>The Proportion Derived by Dividing NN50 by the Total Number of NN intervals (%)</td>
</tr>
<tr>
<td>22</td>
<td>30: 15 Ratio</td>
<td>The Ratio of Maximum and Minimum R-R interval around 30th and 15th beat respectively on Standing Up</td>
</tr>
</tbody>
</table>

Note:  
- $f =$ Frequency  
- ms = Miliseconds  
- ms² = Miliseconds Square  
- % = Percentage  
- mm of Hg = Milimeter of Mercury
The selected autonomic variables were classified on the basis of autonomic literature for accomplishing the objectives which have been documented in given Table-7

**Table-7**

**Classification of Selected Variables**

<table>
<thead>
<tr>
<th>Autonomic Nervous System</th>
<th>Sympathetic</th>
<th>Parasympathetic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Reactivity</td>
<td>Activity</td>
</tr>
<tr>
<td>SDNN</td>
<td>HGT</td>
<td>SDANN</td>
</tr>
<tr>
<td>LF (n.u)</td>
<td>CPT</td>
<td>RMSSD</td>
</tr>
<tr>
<td>LF/HF Ratio</td>
<td>LST</td>
<td>SDSD</td>
</tr>
<tr>
<td>LF (AP)</td>
<td>NN50 Count</td>
<td>DBT (Ch. in HR)</td>
</tr>
<tr>
<td>TP (AP)</td>
<td>pNN50 Count</td>
<td></td>
</tr>
</tbody>
</table>

### 3.3. Equipments Used

#### 3.3.1. Digital Polygraph and Transducers

A two channel computerized polygraph model PC-2004 (Medicaid Systems, Chandigarh, India) was used in the study. The polygraph had two channels – ECG and respiration. The polygraph was connected to master switch to regulate power into the system and the polygraph was connected to computer where signals were recorded in the ‘Physio-pac’ software. The software had one separate channel which gave heart rate at every second. Both ECG and respiration were recorded simultaneously and were measured.
Recorders provided a permanent visual record of an electrical signal. The electronic recording system consisted of three important components. Firstly, the electrode or transducer picked up the bioelectrical potentials whereas the transducer converted the physiological signal to be measured into a usable electrical output. Secondly, the signal conditioner converted the output of the transducer into an electrical quantity suitable for operating the writing system. Thirdly, the writing system provided a visible graphic representation of the quantity of the physiological variable of interest.

The signal conditioner consisted of a preamplifier and the main amplifier. Both these amplifier satisfied specific operating requirements such as input impedance, gain and frequency response characteristics for a faithful reproduction of the input signal.
3.3.2. Hand Grip Dynamometer

A very efficient hand grip dynamometer (Lafayette Instrument Company, USA) was used to measure maximum voluntary contraction. It was held in hand comfortably. It had a scale in kilogram (Kg) and a pointer which shows the isometric strength on pressing the dynamometer.

![Hand Grip Dynamometer with Handle Pad](image)

**Figure 2: Hand Grip Dynamometer with Handle Pad**

3.3.3. Improvised Manometer for Valsalva Manoeuvre Test

A mercury momanometer was used for valsalva manoeuvre test consisted of a bulb filled with mercury (standard mercury manometer). At the end it was connected to a mouth piece through rubber tubing.

![Improvised Manometer for Valsalva Manoeuvre Test](image)

**Figure 3: Improvised Manometer for Valsalva Manoeuvre Test**
3.3.4. **Stethoscope and Sphygmomanometer**

A standard stethoscope and sphygmomanometer were used to measure the blood pressure.

![Figure 4: Stethoscope and Sphygmomanometer](image)

3.3.5. **Ice Box and Thermometer**

An ice box was used to maintain the temperature of water at 10 degree Celsius for cold pressure test and to check the temperature a standard thermometer was used.

![Figure 5: Ice Box and Thermometer](image)
3.4. **Tester’s Competency**

To test the autonomic function tests (reactivity and activity) wiz. lying to standing test (LST), deep breathing test (DBT), valsalva manoeuvre (VM), hand grip test (HGT), cold pressure test (CPT) and heart rate variability (activity) respectively, tester attended training in Biomechanics Laboratory, Indira Gandhi Institute of Physical Education and Sports Sciences (IGIPESS), Vikas Puri, New Delhi, under the supervision of Dr. Dhananjay Shaw (Associate Professor, IGIPESS).

3.5. **Reliability of Instruments**

Standard instruments were used to perform the autonomic functions testing. The digital polygraph of Medicaid Company, Chandhigarh, India was used for the research. The variables of heart rate variability (HRV) were analyzed by using the HRV software developed by AIIMS, New Delhi and Biomedical Signal Analysis Group, Department of Applied Physics, University of Kudopio, Finland. Before any recording the instruments were calibrated and ensured for best performance.

3.6. **Reliability of Data**

The reliability of data was ensured by recording a set of data by research scholar, simultaneously the same samples were recorded by Dr. Dhananjay Shaw and Dr. Pawan Dabas as second set of data. When correlation between two sets of data on same samples was exceeded .99, the researcher was considered competent enough to record the data.

3.7. **Procedure of Recording of Physiological Variables**

The study was conducted in Prajapita Brahma Kumaris Ishwariya Vishwa Vidyalaya, Shiv Darshan Gyan Mandir, Jaitpur Ext., New Delhi-110044. The following instructions were given to the subjects in advance:

1. No consumption of food in any form two hours before the recording.
2. No consumption of tea, coffee or caffienated beverages two hours before the recording.
3. Drugs known to affect cardiac autonomic functions like anti cholinergics (including anti depressants, anti histamions and over-the-counter cough and cold medications), sympathomimetic and parasympathomimetic agents were stopped after consultation with the physician for two days prior to testing. 

4. The subjects were dressed with loose and comfortable clothing. 

5. The recording of all the parameters were made under laboratory conditions in comfortable temperature at the morning. 

3.7.1. Pre-recording Procedure

Subjects were made comfortable and were explained about the entire procedure before the recording was made. The ECG electrodes were fixed as limb leads. The electrode pins were then connected to the electrode board which was in turn was connected to the digital polygraph. The stethograph was strapped around the subjects stomach and was connected to digital polygraph. The sphygmomanometer cuff was tied around the left arm of the subjects for recording the blood pressure. After this subjects were asked to lie down. 

After the application of electrodes and stethogram, the subjects were asked to lie down for 10 to 15 minutes in supine position.
3.7.2. Autonomic Function Tests

A battery of five tests was used to assess the autonomic functions status of the subjects. The procedure followed for the autonomic function tests is described below in detail.

3.7.2.1. Recording of Resting Variables

Procedure

After the rest for 10 to 15 minutes in supine position, the electrophysiological signals (ECG and respiration) were stored in computer for a period of five minutes. After the recording was over, the resting blood pressure was recorded. The stored data and the blood pressure were used for the analysis of autonomic activity (tone). The tracings of ECG and respiration were continued on the computer software for the measurement of autonomic reactivity.

Scoring

The recorded ECG was analyzed for HRV (time domain and frequency domain) variables using softwares.

Figure 7: Recording of Resting Variables
3.7.2.2. Recording of Reactivity Variables

3.7.2.2.1. Lying to Standing Test

Procedure

The subjects were instructed about the test. The test was conducted after 10 minutes of supine rest. Then she was told to attain the standing posture within three seconds and recordings were taken.¹

Recording

The subjects were asked to stand on both the legs and equal weight to be put on both the legs. The blood pressure and heart rate were recorded at base line (pre recording) and serially at 0.5th, 1st, 2nd, 2.5th and 5th minutes following the standing posture. 30:15 ratio were calculated from ECG.

Figure 8: Lying to Standing Test

3.7.2.2.2. Deep Breathing Test

Procedure

The subjects were instructed that in deep breathing test, breathing should be smooth, slow and deep. The investigator gave the hand signal to maintain the rate and timing of the breathing. The subjects were instructed to breath at the rate of six breaths per minute. If cycles were not appropriately done, it was repeated again in order to get six complete cycles (i.e. each cycle consisting of five second inspiration followed by five second expiration).

Recording

Inspiratory and expiratory periods were identified with the help of stethographic respiratory tracings. The mean ratio of expiratory and inspiratory R-R intervals (E:I) and the heart rate differences were calculated from the ECG tracings.

Figure 9: Deep Breathing Test

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Chapter III
Procedure of the Study

3.7.2.2.3. Valsalva Manoeuvre Test

Procedure

After three to five minutes of deep breathing test the subjects were asked to perform valsalva manoeuvre test. The subjects were asked to increase the intrathoracic pressure after normal inspiration by expiring forcefully into the mouthpiece attached to a mercury manometer. The expiratory pressure was raised to 40 mmHg and maintained for 15 seconds.\(^3\)\(^4\) A small air leak in system is useful to prevent the closure of glottis during the manoeuvre. At the end of 15 seconds pressure was released and the subjects were asked to sit quietly and breathe normally. Due care was taken to prevent deep breathing before and after the manoeuvre. During and post manoeuvre phases were identified with the help of stethographic respiratory tracing and ECG tracing.

Recording

The valsalva, bradycardia and tachycardia ratios were calculated from the ECG recorded during the test (calculation formulae given later).

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3.7.2.2.4. **Hand Grip Test**

**Procedure**

The subjects have taken three to five minutes rest after valsalva manoeuvre test, thereafter the baseline blood pressure was recorded. The subjects were instructed about the test and researcher demonstrated the procedure of hand grip test using a hand grip dynamometer. After the instructions and demonstration, the subjects were asked to grip the hand grip dynamometer using maximum voluntary contraction (MVC) force with their dominant hand for a few seconds and the process was repeated three times with sufficient rest in between. The maximum value of the three readings was considered as their MVC. A mark was made on dynamometer at 30% of MVC. The subjects were asked to grip the hand grip dynamometer and to maintain (sustained) the grip on the dynamometer up to mark for four minutes.\(^5\)

**Recording**

The blood pressure (BP) was recorded on the contra-lateral arm at 1\(^{st}\), 2\(^{nd}\), 4\(^{th}\) (or any time just before release of grip if it is less than four minutes). One more reading was taken two minutes after the release of the grip i.e. at sixth minute.

---

3.7.2.2.5. Cold Pressure Test

**Procedure**

After the base line blood pressure was recorded, the subjects were asked to immerse right hand in cold water of 10 degree celsius for one minute.°

**Recording**

The BP was recorded at just before the hand was taken out of the water (i.e. at the end of one minute of immersion). The BP was taken again at 2.5 minutes and 5 minutes after performing the autonomic function test, the hand was withdrawn from the cold water. After performing the autonomic function tests, the subjects were disconnected from the digital polyrite.

![Figure 12: Cold Pressure Test](image)

3.8. **Extraction and Calculation of the Selected Variables (Scoring)**

The parameters studied were the indicators of autonomic activity and indicators autonomic reactivity. Both the autonomic activity and reactivity were determined and detailed as following for two sub divisions of autonomic nervous system (ANS) i.e. parasympathetic and sympathetic.

---

3.8.1. Autonomic Activity Variables (Extraction and Calculation)

For the parasympathetic and sympathetic activity following parameters were studied.

**Heart Rate Variability (HRV)**

**Time Domain Analysis:** The heart rate variability variables were determined by statistical (parametric) analysis using time domain measures, from the R-R interval data the standard deviation (SD) of R-R intervals, RMSSD (square root of mean square of successive R-R interval difference), NN50 (number of interval differences of successive R-R intervals greater than 50 ms), SDSD (Standard deviation of differences between adjacent NN intervals), SDANN (Standard deviation of the averages of NN intervals in all five minutes segments of the entire recording) and pNN50 (the proportion derived by dividing NN50 by total number of R-R intervals) were calculated (Special Report).\(^7\)

The variance is mathematically equal to total power of spectral analysis, SD reflects all the cyclic components responsible for variability in the entire period of recording (Special Report, 1996).\(^8\) In other words, SD of RR intervals signifies both the parasympathetic and sympathetic tone and gives an idea of total variability. The RMSSD and pNN50 are highly correlated with HF, hence signifies the parasympathetic tone.\(^9\)

**Frequency Domain Analysis:** The stored ECG from the computer was played in HRV analysis software. The analog data (ECG signal) was sampled at frequency of 256 Hz. The data (analog signal) was manually edited on computer for any artifact and ectopic beats. In a clear epoch of five minutes of the R-wave of QRS complex was detected by using amplitude criteria and R-R intervals were measured. The duration of five minutes was chosen since it is more than epoch period valid for HRV analysis (Special Report, 1996).\(^10\) The R-R intervals were converted into equidistance time series by method of

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\(^8\) Ibid.

\(^9\) Ibid.

\(^10\) Ibid.
interpolation. The fast fourier transformation (FFT) of these R-R intervals verses time plot was carried out at four Hz sampling rate. This gives frequency spectrum of the HRV. The software AUTONOMIC FUNCTION TEST HRV_ Soft version 1.1 was developed in autonomic function laboratory. All India Institute of Medical Sciences (AIIMS), New Delhi. The frequency range of less than or equal to 0.04 Hz is considered as very low frequency (VLF), 0.04 – 0.15 Hz as low frequency (LF) and from 0.15 – 0.40 as high frequency (HF). The data was obtained from the frequency domain analysis in the conducted study was in terms of total power (TP), LF and HF power, LF/HF, LF normalized and HF normalized. The power of LF is equated with sympathetic and in HF band is with parasympathetic control. The ratio of LF/HF has been considered to be mediated by sympathovagal balance. The normalization of LF (normalized) and HF (normalized) represents the relative value of each power component in proportion to total power minus VLF.

3.8.2. Autonomic Reactivity Variables (Extraction and Calculation)

The measurements of parasympathetic and sympathetic reactivity were done by using a battery of five tests. The parameters derived from these tests have been described as follows.

3.8.2.1. Parasympathetic Reactivity Variables (Extraction and Calculation)

Deep breathing Test Score (Change in Heart Rate): Change in heart rate was calculated from ECG tracings of the minimum and maximum R-R intervals during expiration and inspiration respectively during deep breathing test for six respiratory cycles.

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15 Ibid.
**Chapter III**

**Procedure of the Study**

**Expiratory – Inspiratory Ratio (E:I):** It is the ratio of the minimum and maximum R-R intervals during expiration and inspiration respectively during deep breathing test. The maximum and minimum R-R intervals were measured from ECG for six respiratory cycles.\(^{16}\) All maximum and minimum R-R intervals were averaged and E:I ratio was worked out with the help of following formula.

\[
\frac{\text{Maximum R-R interval during expiration}}{\text{Minimum R-R interval during inspiration}} = \frac{E}{I}
\]

**Valsalva Manoeuvre Ratio:** The cardiovascular responses to valsalva manoeuvre are divisible at the following four phases:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
<th>HR Change</th>
<th>BP Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Onset of strain</td>
<td>Decrease</td>
<td>Increase</td>
</tr>
<tr>
<td>II</td>
<td>During strain</td>
<td>Increase</td>
<td>Decrease</td>
</tr>
<tr>
<td>III</td>
<td>Strain released</td>
<td>Further increase</td>
<td>Decrease</td>
</tr>
<tr>
<td>IV</td>
<td>Post Manoeuvre</td>
<td>Reduction of HR</td>
<td>Overshoot in BP</td>
</tr>
</tbody>
</table>

The valsalva manoeuvre ratio was calculated from the ECG recorded during the manoeuvre. It is the ratio of the maximum R-R interval during phase IV to the minimum R-R interval during Phase II according to following formula.

\[
\frac{\text{Maximum R-R interval during phase IV}}{\text{Minimum R-R interval during Phase II}} = \frac{\text{V} \text{a}l\text{s}a\text{l}v\text{a} \text{ M}a\text{n}o\text{o}u\text{e}uvre \text{ R}a\text{i}t\text{i}o}n
\]

**30:15 Ratio:** This ratio was calculated from the ECG recorded during lying to standing test. There is an increase in heart rate (tachycardia) immediately on standing up from lying posture around 15\(^{th}\) beat and decrease in heart rate (bradycardia) around 30\(^{th}\) beat. The ratio of maximum and minimum R-R interval around 30\(^{th}\) and 15\(^{th}\) beat respectively on standing up was 30:15 ratio.\(^{17}\)

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3.8.2.2. Sympathetic Reactivity Variables (Extraction and Calculation)

**Blood Pressure (BP) Responses to Lying to Standing Test Score:** During the lying to standing test BP was measured at zero minute i.e. in lying position and at 0.5th, 1st and 2nd minute of standing up. The differences in systolic pressures at 0.5th, 1st, and 2nd minute of standing from that of respective lying (baseline; zero minute) pressures were calculated.

**Blood Pressure (BP) Responses to Hand Grip Test Score:** During the test the BP was measured at 0, 1st, 2nd, 4th and 6th minute of the onset of isometric contraction. The diastolic pressure differences from the (baseline; zero min) were calculated at 2nd and 4th minute of contraction.

**Blood Pressure (BP) Responses to Cold Pressure Test Score:** The BP was measured at 1st and 2.5th minute of immersion of hand in cold water for one minute. The diastolic pressure differences at 1st minute of the (base line ; zero minute) was calculated.

### 3.9. Training Schedule

The details of the training schedule have been documented in table-8.

#### Table-8

<table>
<thead>
<tr>
<th>Duration</th>
<th>Phase</th>
<th>Training Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 minutes</td>
<td>Preparatory Phase</td>
<td>Attendance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Body Stretch-upward and sideward</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neck Stretches</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shoulder Rotations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hamstring and Quadriceps Stretches</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hip Circumduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Five Deep Breathing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Five Om Recitations</td>
</tr>
<tr>
<td>Initially fixed</td>
<td>Main Phase (kriyas/ Pranayamas)</td>
<td>Anulom Vilom Practices</td>
</tr>
<tr>
<td>20 minutes</td>
<td></td>
<td>Kapalbhati Practices</td>
</tr>
<tr>
<td>Depending upon</td>
<td></td>
<td>Bhamari Practices</td>
</tr>
<tr>
<td>the adaptations,</td>
<td></td>
<td>Agnisar Practices</td>
</tr>
<tr>
<td>session was</td>
<td></td>
<td><strong>Note:</strong> According to designated experimental group for specific Kriya/ Pranayamas Practices</td>
</tr>
<tr>
<td>increased to</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 minutes</td>
<td>Final Phase</td>
<td>Shavasana</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Feedback/ suggestions /conclusions</td>
</tr>
</tbody>
</table>
3.10. **Training Protocol and Training Procedure**

3.10.1. **Training Protocol**

- Each group was trained for six weeks.
- Each selected group was administered with 20 to 30 minutes yogic training (specific Kriya / Pranayama) according to the designated group for six days per week and at least twice a week was compulsory attendance for each sample or participant.

3.10.2. **Training Procedure**

(i) **Anulom Vilom**

**Steps to Perform**

It was practiced by sitting in comfortable position (sukhasana), Alternate nostrils closed, gently by using the right hand's thumb and ring finger or little finger. The thumb used for closing the right nostril and the ring and little fingers used to close the left nostril. The mouth closed and not used for breathing. No sound should be produced while inhaling or exhaling.

**The Cycle of Practice**

- The right nostril closed with the thumb. Air exhaled through the left nostril and then inhaled back through the same nostril.
- The left nostril closed with the ring finger or little finger. Air exhaled through the right nostril and then inhaled back through the same nostril.

This repeated at a normal breathing rate. It was advised to have an inhale and exhale ratio equal to 1: 2.18

(ii) **Kapalbhati**

**Steps to Perform**

- Keet breathing gradually while sitting in a comfortable position (sukhasana).
- Elongated spine upwards, lengthened neck, soldier at attention. That aligned the spine with the back and head.

• Closed eyes.
• Hands in gyan mudra. In gyan mudra the thumb tips and index finger met, with the wrists resting gently on the knees and the palms turned slightly upwards.
• Relaxed stomach muscles.
• Thereafter expelled the air as forcefully as one was comfortably through the nose simultaneously. The abdominal muscles contracted sharply and drewed the abdomen inwards towards the spine. Then allowed the inhalation to occur completely passively without any additional effort. Repeatly, the exhalation done using conscious sharp force, while the inhalation was just a recoil action brought the air back into the lungs. All the breathing took place through the nose. Right after the passive inhalation, exhaled again forcefully and continued at a steady rhythm.
• One set or round consisted 10 repetitions.
• Worked way up to five rounds, while took a break between each round.

Note: Unlike doing bhastrika yoga pranayama one uses force during both the inhalation and the exhalation, in kapalbhati force was used only during the exhalation.19

(iii) Bhramari

In bhramari, the lips were closed and vibrations of the soft palate are caused entirely by nasal airflow unlike the usual mouth snoring.

Steps to Perform

• Kept breathing gradually while sitting in a comfortable position (sukhasana).
• The soft palate was lifted toward the top of the pharynx sufficiently to produce flutter. The sound produced was commonly described as similar to the buzzing of a bee.
• Although, in bhramari, one breathed both in and out through both nostrils, producing a snoring, buzzing or humming while exhaling.
• The sound produced was somewhat different, inhaling produces a sound with a higher /deeper breathing than exhaling which has a lower and elongated pitch.20

19 Kapalbhati Yoga Breathing Exercise for Optimum Health & Healing- Free Online Pranayama Book- Ch 5.
20 www.holistic-online.com.
(iv) Agnisar

Steps to Perform

- Kept breathing gradually while sitting in a comfortable position (sukhasana).
- Took support by resting the hands on knees so that the back was not strained. It was ensured that the arms were straight.
- After that, breathed in deeply. After that, exhaled fully contracting the abdomen so that all the air was expelled. While holding breath in this position, contracted or 'flapped' the abdominal muscles in and out. It was noted that performance was done rapidly while holding the exhaled position without inhaling. Subjects were performing the same as many times it was possible and then took a slow, deep breath inside. This was one round of the practice.

In the beginning three such rounds were allowed, each of 10 flapping cycles were considered as more than enough. Such practice was gradually built up to 100 inward-outward flapping cycles in each round.\(^{21}\)

3.11. Research Design

Test-retest design for eight matched groups (each corresponding experimental and control groups were homogenous in regard to age, resting heart rate, systolic blood pressure and diastolic blood pressure) was adopted as following:

i. To compare between the pre test and post test of experimental group of anulom vilom.
ii. To compare between the pre test and post test of control group of anulom vilom.
iii. To compare between the pre test and post test of experimental group of kapalbhati.
iv. To compare between the pre test and post test of control group of kapalbhati.
v. To compare between the pre test and post test of experimental group of bhramari.
vi. To compare between the pre test and post test of control group of bhramari.

vii. To compare between the pre test and post test of experimental group of agnisar.
viii. To compare between the pre test and post test of control group of agnisar.

Note: 1. Pre test was conducted before any specific training/treatment (anulom vilom or kapalbhati or bhramari or agnisar).
2. Post test was conducted after specific training/treatment (anulom vilom or kapalbhati or bhramari or agnisar).

3.12. Statistical Analysis of the Data

Following statistical techniques were administered for the analysis of data:

1. Descriptive Statistics
   - Mean and
   - Standard deviation

2. “t” test to compare between the corresponding pre test and post test scores as following:
   - To compare between the pre test and post test of experimental group of anulom vilom.
   - To compare between the pre test and post test of control group of anulom vilom.
   - To compare between the pre test and post test of experimental group of kapalbhati.
   - To compare between the pre test and post test of control group of kapalbhati.
   - To compare between the pre test and post test of experimental group of bhramari.
   - To compare between the pre test and post test of control group of bhramari.
   - To compare between the pre test and post test of experimental group of agnisar.
   - To compare between the pre test and post test of control group of agnisar.

The drawn hypotheses were tested at 0.05 level of significance.