MATERIALS & METHOD
3.1 STUDY DESIGN/TYP e: Descriptive, Inferential design.

3.2 STUDY SETTINGS: The place of work was at a Software Industry and a Business Process Outsourcing (B.P.O) at Bangalore, India.

3.3 SAMPLE SIZE: 500 computer workers were taken for study from above settings.

3.4 SAMPLING: Systematic random sampling has been done in this study.

3.5 SELECTION CRITERIA: Selection was based on inclusion and exclusion criteria as follows,

3.5.1 Inclusion criteria:
3.5.1a. Age group of 21 to 35 years,
3.5.1b. Subjects of both genders,
3.5.1c. Educational qualification: Professional degree and above in engineering and computer science along with (upper (I) socioeconomic status) (Kupuswamy 1981, Mishra and Singh 2003, Kumar et al. 2007)
3.5.1d. Working experience more than one year,
3.5.1e. Subjects working duration: 8 hours (www.legalindia.com) or more per day,
3.5.1f. Subjects did not perform stretching exercises/protocols past one year,
3.5.1g. People present during data collection,
3.5.1h. Willingness towards participation,
3.5.2 Exclusion criteria:
3.5.2a. People suffering from chronic illness except occupational related,
3.5.2b. Subjects who underwent major surgery,
3.5.2c. Part-time workers,
3.5.2d. Visual problems,
3.5.2e. Post-traumatic stiff joint,
3.5.2f. Fixed deformity,
3.5.2g. Weakness and paralysis of limbs.

3.6 PILOT STUDY:
The pilot study was carried out with 100 computer professionals. Subjects were selected based on inclusion and exclusion criteria along with fulfillment of ergonomic checklist.

Parameters such as static (standing) and dynamic (work sitting) posture, body flexibility, work related musculoskeletal discomfort, occupational stress and BMI of computer professionals have been assessed.

The tools used in this study were found to have consistency in their reliability and validity. The test-retest reliability has been checked. Reliability of modified sit-and- reach test score using sit-and-reach test box was 0.994, reliability of OSI questionnaire was 0.984, reliability of Cornell University’s Work related Musculoskeletal Discomfort Questionnaire was 0.991. There was good inter-rater and intra-rater reliability of plumb bob. The weighing machine and standing frame for measuring height were the standard tools used in the study.

An association was checked between the scores of different BMI of computer professionals with their posture, flexibility, work related musculoskeletal discomfort and occupational stress index.

In the result of the pilot study, it has been found that among 86% of male and 16% of female subjects, 64% noted in increased BMI group in a random selection which indicates
a majority of computer workers fall under high BMI group. A maximum 67.9% male subject was noted in the age group of 31-35 years for different type of involvements in psychophysical health.

Association of BMI with Static (standing) Posture, Dynamic (sitting work) posture ($\chi^2$=95.726 & p<0.001), Work Related Musculoskeletal Discomfort (F=136.137, p<0.001), Occupational Stress (F=422.295, p<0.001) and Flexibility (F=200.493, p<0.001) had been noted.

Multivariate Discriminant Function Analysis was done to predict the BMI based on four parameters. It had been noted that as the BMI increases the scores of dynamic (work) posture significantly increases (P<0.001), Work-related musculoskeletal discomfort increases (P<0.001), Occupational stress increases (P<0.001) and Flexibility decreases (P<0.001). Hence the computer professionals with high BMI had faulty standing and work sitting posture, poor body flexibility, increased work related musculoskeletal discomfort and occupational stress.

3.7 MAIN STUDY:
3.7a. Sampling procedure:
The subjects of the present study were randomly selected in two groups with following profiles.

Flowchart 3.1.1: Division of sample

<table>
<thead>
<tr>
<th>Sample size (N=500)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPO Operators (N=250)</td>
</tr>
</tbody>
</table>
3.7b. Computer professionals sample profile:

**Age profile**

**Total**
(N=500)

- **21-25 years**
  (N=320)
- **26 – 30 years**
  (N = 121)
- **31-35 years**
  (N=59)

Flowchart 3.1.2: Division of age profile

Fig. 3.1: Age group of computer workers:
Fig. 3.2: Gender profile of computer workers:

![Gender profile chart]

Fig. 3.3: Type of company:

![Type of company chart]
Fig. 3.4: Job Profiles of computer workers:

BMI ≥ 25 = 64.80%
BMI > 18.5 - 24.9 = 15.20%
BMI < 18.5 = 20%

Fig. 3.5: BMI profile of computer workers:
Fig. 3.6: BMI distribution among genders of computer workers:
3.8. PARAMETERS USED IN STUDY:


3.10b. Posture: Static (standing posture) consists of two categories; correct posture and faulty posture and Dynamic (sitting work) posture score with different scores during their computing work.

3.10c. Flexibility: Extensibility of lower back and hamstring muscles was taken for flexibility of the body.

3.10d. Work related musculoskeletal discomfort: Pain and discomfort in 18 different body parts; Neck, Shoulder (right), Shoulder (left), Upper Back, Upper arm(right), Upper arm (left), Lower Back, Forearm (right), Fore arm (left), Wrist (right), Wrist (left), Hip, Thigh (right), Thigh (left), Knee (right), Knee (left), Lower leg (right), Lower leg (left).

3.10e. Occupational stress: Occupational psychosocial stress were taken with 12 stressors; Role overloads, Role ambiguity, Role conflict, Unreasonable group & political pressure, Responsibility, Under participation, Powerlessness, Poor peer relation, Intrinsic impoverishment, Low status, Strenuous working condition, Unprofitability.

3.9. TOOLS USED IN STUDY:

3.9a. (i) Ergonomic design of computer workstation with anthropometric data of workers and (ii) OSHA Ergonomic Solutions: Computer workstations eTool- Evaluation checklist for confirmation of developed ergonomic setup.

3.9b. Height frame and weighing machine: to measure height and weight for calculation of Body Mass Index,

3.9c. Plumb bob: used for measurement of standing (static) posture.

3.9d. Cornell University’s Rapid Upper Limb Assessment (RULA) score chart: used for work sitting posture during computing task.
3.9e. Modified sit and reach assessment score chart and sit-and-reach test box: used for measurement of flexibility of lower back and hamstring muscles.

3.9f. Cornell University’s WMSD Questionnaire: taken for measurement of work related musculoskeletal discomfort.

3.9g. Occupational Stress Index Questionnaire: used for measurement of occupational stress.

3.10. DURATION OF STUDY: The total study period was of two and a half years.

3.11. PROCEDURE:

Standard height frame and weighing machine have been used for the measurement of height and weight respectively. BMI (William et al. 1990, WHO 1997, Bethesda 1998) was calculated by taking the ratio of the subject’s height (in meter) and weight (in kilogram) i.e. (weight/(height)^2). BMI has been divided into three groups; Low BMI (<18.5), Medium BMI (18.5-24.9) and high BMI (≥25).

Standing posture was assessed with the help of plumb bob (Kendal 1993, Kerrie 2006) passing the line in lateral and posterior aspect of the body finding the correct (YES) or faulty (NO) posture taken for the calculation.

Dynamic (work sitting) posture was checked with observation during the work (two to six working hours of the day) by using the RULA (Rapid Upper Limb Assessment) employee assessment worksheet (Lynn and Nigel 1993). The scores for the scale consist of 1 or
2=acceptable, 3 or 4=investigate further, 5 or 6=investigate further and change soon, 7=investigate and change immediately.

Flexibility of lower back and hamstring muscles was assessed by modified sit and reach test score (Tsang and Mak 2004) using a sit-and-reach test box and the score was taken for the consideration. The sit and reach test box (Base: 18" Length X 12" Width X 13-3/4" Height and Top: 27 1/2" Length X 12" Width, as per Lafayette adjustable Sit and Reach Flexibility Tester 2003) has been tested and found good test-retest reliability (0.994). The sit and reach test scores (Wells and Dillon 1952, Davis 2000) are considered in 7 grades; Very poor (1), Poor (2), Fair (3), Average (4) and Good (5), Excellent (6), Super (7). The very poor (grade 1) consists of <-20 score for men and <-15 for women, poor (grade 2) consists of -19 to -9 for men and -14 to -8 for women, fair (grade 3) consists of -8 to -1 for men and -7 to 0 for women, average (grade 4) consists of 0 to +5 for men and +1 to +10 for women, good (grade 5) consists of +6 to +16 for men and +11 to +20 for women, excellent (grade 6) consists of +17 to +27 for men and +21 to +30 for women, super (grade 7) consists of >+27 for men and >+30 for women. The test involves sitting on the floor with the back and head against a wall, legs fully extended with the bottom of the feet against the sit-and-reach box. Later, placing the hands on top of each other, stretching the arms forward while keeping the head and back against the wall. The distance has been measured from the fingertips to the box edge with a ruler. This becomes zero or starting point. Later slowly bending and reaching forward as far as possible sliding the fingers along the ruler, holding the final position for two seconds and the distance reached was recorded. The test was repeated three times, and the best distance was noted for the score. In this study, the grade has been taken for consideration.

Work related musculoskeletal discomfort (WMSD) was assessed by Cornell University’s Work related Musculoskeletal Discomfort Questionnaire (Hedge et al. 1999, Oguzhan et al. 2008) and the score was calculated. The questionnaire contains frequency score, discomfort score and interference score. The frequency score consists of (a) never=0, (b) 1-2 times/week=1.5, (c) 3-4 times/week=3.5, (d) every day=5 and (e) several times a day=10. The discomfort score consists of (a) slightly uncomfortable=1, (b) moderately
uncomfortable=2 and (c) very uncomfortable=3. The interference score consists of (a) not at all=1, (b) slightly interfered=2, (c) substantially interfered=3. Final score of each body part was calculated by multiplying above frequency score (0, 1.5, 3.5, 5, 10) by discomfort score (1, 2, 3) by interference score (1, 2, 3). Net score of all body parts was calculated by adding the final scores of each body part. Scores of 18 body parts has been measured and divided as follows. Mild discomfort: 1-540, Moderate discomfort: 541-1080, Severe discomfort: 1081-1620.

Occupational stress (psychosocial stress) was assessed by Occupational Stress Index (OSI) questionnaire (Srivastava and Singh 1981, 1984) and the score was calculated. The OSI scale consists of 46 questionnaires, each to be rated on the five point scale. Out of 46 items 28 are true-keyed and 18 are false-keyed. The items relate to almost all 12 relevant components of job life which causes stress in some way or the other such as role overload, role ambiguity, role conflict, unreasonable group and political pressure, responsibility for person, under participation, powerlessness, poor peer relations, intrinsic impoverishment, low status, strenuous working condition and unprofitability. The OSI scores and grades are as follows; 1 – 46 with No stress, 47 – 76 with mild stress as Grade I, 77 – 152 with moderate stress as Grade II, 153 – 230 with severe stress as Grade III.

In the present study the above stress grades were adopted with slight modification and are classified as follows; 1-76 with mild stress as Grade I, 77–152 with moderate stress as Grade II, 153-230 with severe stress as Grade III.

An association was checked between the scores of different BMI of computer professionals with their posture, flexibility, work related musculoskeletal discomfort and occupational stress.

The tools used in this study found to have consistency in their reliability and validity. As in the case of this research scholar, skills in measuring these variables are accurate because the scholar has more than fifteen years of experience in measuring and treating musculoskeletal disorders.
Plate 3.1: Height frame
Plate 3.2: Weighing machine
Plate 3.3: A subject’s height is being measured by height frame
Plate 3.4: Plumb bob and scale
Plate 3.5: A subject’s standing posture is being checked by plumb bob (lateral aspect)
Plate 3.6: A subject’s standing posture is being checked by plumb bob (posterior aspect)
Plate 3.7: Subjects are in developed ergonomic setup
Plate 3.8: A Subject is being observed in developed ergonomic setup
Plate 3.9: A Subject is being assessed by RULA worksheet in developed ergonomic setup
Plate 3.10: A subject is being assessed by sit-and-reach test box for flexibility (initial range)
Plate 3.11: A subject is being assessed by sit-and-reach test box for flexibility (final range)
Plate 3.12: A female subject is being assessed by sit-and-reach test box for flexibility (initial range)
Plate 3.13: A female subject is being assessed by sit-and-reach test box for flexibility (final range)
3.12. STATISTICAL TREATMENT:

The data were statistically treated with a frequency distribution, percentage-chi-square test of association, analysis of variance, multiple regression analysis, logistic regression and Cochran-Mantel-Haenszel test.

Chi-Square Test:

Chi-square test of Association is a statistical test for testing the null hypothesis that the distribution of a discrete random variable coincides with a given distribution.

Analysis of Variance:

A statistical technique which helps in making inference, whether three or more samples might come from populations having the same mean, specifically, whether the difference among the samples might be caused by chance variation.

Multiple Regression Analysis:

Multiple (linear) regression is a regression technique aimed at finding a linear relationship between the dependent variable and multiple independent variables.

The multiple regression models are as follows:

\[ Y_i = B_0 + B_1 X_{1i} + B_2 + X_{2i} + \ldots + B_m X_{mi} + E_i, \quad i = 1, \ldots, N, \]

Where \( Y_i \) is values of the dependent variable,

\( X_{1i}, X_{2i}, \ldots, X_{mi} \) are values of \( M \) independent variables, \( E_i \) – random errors, \( N > m + 1 \) is the sample size, multiple regression finds the set of parameters \( B_{0i}, B_{1i}, \ldots, B_{mi} \) that
provides the best fit between the model and the given data (which are a set of \( N \) vectors 
\( \{(y_i, X_{1i}, \ldots, X_{mi}), i = 1, \ldots, N\} \)).

Logistic regression:
Logistic regression is used with binary data when we want to model the probability that a 
specific outcome well occurred. Specifically, it is aimed at estimating parameters \( a \) and \( b \) in 
the following model:

\[
Li = \log \frac{Pi}{1 - Pi} = a + b \times i,
\]

Where \( Pi \) is the probability of a success for given value \( X_i \) of the explanatory variable \( X \). 
use of the log of the odds \( p/(1-p) \) (the logit) guarantees that the predicted value of \( P \) will 
always be between 0 and 1.

Cochran-Mantel-Haenszel Test:

The Cochran-Mantel Haenszel test compares two groups on a binary response, adjusting 
for control variables. The initial data are represented as a series of \( K \times 2 \times 2 \) contingency 
tables, where \( K \) is the number of strata. The null Hypothesis is that the response is 
conditionally independent of the treatment in any given strata. The stratification of the 
subjects into \( K \) groups (according to the values of controlled variables – e.g. “age group”) 
increases the power of the test to detect association. This increase in power comes from 
comparing like subjects to like subjects.

The data were fed to the computer, and some of the statistical analyses were done by using 
the strata package.