DISCUSSION

Computer worker's health is foremost important for better productivity of any IT or BPO Company. Correct ergonomic setup, frequent rest, stretching and strengthening exercises may reduce few degrees of physiological and psychological load in the body, but at the same time importance has to be given for reduction of body weight in their sedentary working life otherwise it might lead to serious work related musculoskeletal disorders and occupational-psychosocial stress in due course of time.

An effort has been made here to find out the influence of BMI over Psychophysical health parameters (RULA, Sit and Reach test, CMDQ and OSI scores) of the subjects in a developed ergonomic setup: Ergonomic design, anthropometric data and OSHA eTool - evaluation checklist. The checklist helped in confirmation of the working posture of computer workers at the workstation as well as the workstation was found ergonomically suitable according to technical user comfort for every subject. Male dominated subjects (407 males and 93 females of sample size) were considered here because of their voluntary willingness towards the participation. Out of 1068 subjects (534 software engineers & 534 BPO operators) 68 of them has been excluded during checking of selection criteria, later 500 (250 software engineers & 250 BPO operators) subjects taken for the study by systematic sampling. Among 250 software engineers there were 211 males and 39 females, as well as among 250 BPO operators 196 males and 54 females were participated in the study. Mostly female subjects were found more reluctant to participation. After convincement 93 of them could join the study but showed delayed response for measurements. Age group of 21 to 35 years has been considered here especially for non restricted body flexibility of lower back and hamstring muscles. 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) has been noticed during data collection. Work experience of more than one year has been taken here because the subjects do get maximum musculoskeletal complains at that time, which has been confirmed during the interaction. Daily minimum eight hours (www.legalindia.com) of working period (including one hour lunch break and other micro breaks) was taken for the study, but it has been seen that they work more than ten hours on some days due to their workload.

5.1 A. STATIC OR STANDING POSTURE OF COMPUTER WORKERS.

Maintenance of correct posture requires muscles that are strong, flexible and easily adaptable to environmental change. These muscles must continuously work against gravity and in harmony with one another to maintain an upright position. Poor postural habits, muscle imbalance due to tightness, nerve compression, pain, respiratory conditions, excess body weight and structural deformities due to trauma or disease are the contributing factors for altered or poor posture.

It was assumed that, the computer professionals with high BMI tend to have faulty standing (static) posture. In this study, 500 computer professionals were taken for the investigation for their postural analysis especially focused on whether the computer professionals maintain good posture as per their BMI. It has been noted that as the body weight increases, the standing posture tends to alter ($\aleph^2$ p value of age group (21-25years, p= 0.008, 26-30 years, p< 0.001, 31-35 years, p<0.001; table 4.1.A.1). This study shows that the younger age group with moderate BMI (18.5-24.9) is maintaining good posture and physically fit in exerting the computing task by maintaining a moderately good posture (76.92%). High BMI with higher age group had altered standing posture, which might be due to contribution of the age factors to structural changes of bone, joint and soft tissues for a tightness and softness tend to go for an altered posture. Again the influence of high BMI with an increase of age might lead to a definite altered posture even though in an ergonomic setup.

The static posture assumed at work might have adverse effect on joint structure and function. Constant weight bearing in sustained posture and high BMI can lead to impaired function (stiffness) of the lumbo-sacral region, decreased productivity, an absence from work and permanent disability (Pamela and Cynthia 1994). In support of this study Newell 1997 reported that the young adult group of people in their twenties had the least amount of the centre of pressure (COP); the individuals in the youngest and oldest groups have the greatest amount of the centre of pressure. The change of posture (i.e. flexed posture) observed in some elderly is probably due to a number of factors that may be attributed to the aging process, to a sedentary lifestyle or to a combination of ageing and sedentary lifestyle. In normal standing posture, the line of gravity passes through the combined axis of lumbar vertebrae and therefore no net gravitational torque exists. Any deviation of the line of gravity will lead to torque production. The muscle contraction required to oppose the gravitational torque create additional compression on vertebrae as well as torsional and shear stresses. Muscle action, especially of erector spinae, psoas major, multifidus and rotators on the lower lumbar segment go for stiffness as reported by Wilke (1995).

Male and female computer workers of higher BMI group have been seen with faulty posture, whereas, moderate BMI female group was with good posture than the male workers. From the above finding, it is inferred that female computer professionals belong to lower, and higher BMI group shows increased faulty posture than the moderate BMI group whereas, male professionals show good posture in lower BMI group and increased faulty posture in higher BMI group. Majority of male computer workers has a bigger percentage (74.38%) of faulty static (standing) posture compared to their female counterparts. Comparison of gender in relation to BMI reveals that there is a significant association ($\aleph^2 = 71.6370$, $p<0.001$; table 4.1.A.2). As the BMI increase the faulty posture has been seen with both genders but mostly in male workers. From this finding, it has been presumed that working females are beauty conscious, which control their food habit and no smoking tends to maintain good posture compare to their male counterparts. However, for gaining body weight these factors do not have any role. So as the BMI increases there is a more definite chance of increasing faulty static (standing) posture among males than females.

Comparison of the cadre of computer professionals in relation to their BMI reveals that there was a significant association with BMI ($\aleph^2$ value=56.9800, $p<0.001$; table 4.1.A.3). Both the engineers and operators with higher BMI maintain faulty posture, whereas maximum operators had a faulty static posture compare to the engineers (66%). This may be due to constant sustained posture maintained by BPO operators spending long working hours to make a better income compare to the high paid software engineers.

In this study significant association of BMI with the faulty static posture has been found among the computer professionals ($F = 27.27$, $p<0.0001$; table 4.1.A.5). This may be due to their work for longer hours in sustained posture with maximum concentration. The high body mass composition gives rise to sustained pressure on the musculoskeletal system and injures the tissues as compared to lower BMI group. In overweight and obese individuals, the fat deposition occurs in abdomen and pelvis, which lead to changes of position of the spine in relation to the pelvis, imbalance of muscle in the abdomen and lower back which contributes to alteration of posture. Generally, physical activities of the overweight computer professionals are decreased. Work overload and the strenuous working conditions are added effect on these professionals. In support of this finding Bernard *et al*. (2003) reported in their study that obesity significantly influences on the postural control and balance among the teenagers.

Spinal segmental curvatures alter after getting a sufficient load on the vertebral column due to increase of body weight. The body parts; head, trunk and lower limbs, pelvic and pectoral girdles do not make a particular alignment for a good stature of the body. Age, body mass, nourishment and sedentary lifestyle contribute towards the postural misalignment. Decreased range of forward flexion, differing effects within the trunk, altered posture during a standing task and a concomitant increase in hip joint movement give an insight into the etiology of functional decrement and musculoskeletal pain as seen in overweight and obese individuals. As the BMI increases the standing posture alters because of the increased muscle mass and fat deposition. The findings are also supported by Gilleard & Smith (2007) regarding the effect of overweight and obesity on the trunk forward flexion motion in sitting, standing, postural adaptation and hip joint movement for a standing work task which reflects the altered posture.

To infer the absolute source of stress on body tissue because of over body weight, Mantel-Haenszel's analysis for the odd ratio was performed on these data and found that the BMI was absolutely responsible for faulty static (standing) posture. The outcome of Mantel-Haenszel's analysis predicted accurately the influence of BMI on different gender of computer professionals.

The above analysis predicted that every unit of the posture odd's ratio increases along with an increase of BMI ($\aleph^2$ = 9.84, p = 0.0017; table 4.1.A.6) which states that faulty posture was significantly associated with higher BMI, whereas the same principle is not applicable in the male female odd ratio. In case of females the BMI significantly associated with the postural defects. ($\aleph^2$ = 0.03, p = 0.8562). However, the male computer professionals are prone to postural defect as the BMI increases ($\aleph^2$ = 26.39, $p< 0.0001$). Mantel-Haenszel's analysis predicted very high significance in alteration of posture in association with increased BMI.

In the analysis, it was also revealed that there were gender discrepancies with regard to BMI along with the static (standing) postural defects. Women had the better posture, even if the BMI increases as compared to their male counterparts.

5.1 B. DYNAMIC (SITTING WORK) POSTURE OF COMPUTER WORKERS.

It was assumed that computer professionals with high BMI maintain faulty dynamic (sitting work) posture. Faulty dynamic posture maintained by the sedentary computer workers manifest functional decrement and soft tissue injuries in their body. An attempt has been made in this study to find out whether the computer professionals with high BMI have got a faulty dynamic posture.

According to the orientation of body parts in space the dynamic posture is believed to have a preformed effort on health and well being of workers. Working in an unchanging position or static posture has been associated with musculoskeletal disorders. Posture that position the body or body parts tend to adopt so that the muscles must work strongly against the gravity, such as holding arms out at a shoulder height, working with torso bent often cause discomfort in workers. The working position that allows the worker to maintain the normal relaxed posture frequently is considered to put the least amount stress on the body. The position in which the individuals sit can place a great deal of stress on lower back. The so called correct sitting posture in which the individual is positioned at 90 degree hip, knee and elbow flexion with straight back and erect head is a myth that has caused some harm. This position places a greater pressure on lower back than sitting in relaxed posture as well as upper back discomfort because of muscle strain.

Evaluation of dynamic posture has already been studied by many investigators in different Indian industries (Sharma *et al*. 2006, Borah *et al.* 2007, Metgud *et al.* 2008, Singh 2010). It is well known that large numbers of young and dynamic individuals are attracted towards a well paid information technology (IT) profession in the recent past by which country's gross dividend profit (GDP) has been perceptually increased as well as the economic status of the common middle class people has improved. In this current study, although, they are maintaining the normal dynamic posture at the beginning of their growth (42.37%) as they grow older the faulty dynamic (work) posture gradually increases to 82.81% at the age of 31-35 years. The computer professionals of 26-30-years of age group, which is the common age for active adult life for the modern young men and women, they too have shown highly faulty dynamic posture (49.58%). This finding throws a light of possible effect in their adult life and marital harmony, because the profession demands sedentary dynamic posture at work, which invariably may result in varying degrees of musculoskeletal strain. Maximum percentage of people under higher age group has got a faulty dynamic posture score. Chi-square analysis of the data shows high significance ($\aleph^2$ value = 191.8459, $p<0.001$; table 4.1.B.1) association of dynamic posture with their age. This may be due to the adverse effect of posture assumed during work under the higher age limit on the joint structure and function. Constant weight bearing in a sustained position with high BMI can lead to impaired function (stiffness) of joints and muscles in upper limb and spine to put them in faulty dynamic posture (Pamela and Cynthia 2001).

Maximum percentage of male computer professionals was reported with a high faulty dynamic posture (RULA) score compared to their female counterparts. Chi-square analysis was performed, which brought about the significant ($\aleph^2$ value=27.9737, $p<0.001$; table 4.1.B.2) association of dynamic posture score with gender variables. This may be due to working women are posture conscious during their young marital age, as well as they do take dietary and postural advice for flexible body structure, which tends to maintain good posture with lesser RULA score compare to their male counterparts. Significant association of gender BMI groups on their faulty dynamic posture score (for Female $\aleph^2 = 184.000$, $p< 0.001$, for Male $\aleph^2 = 804.4654$, $p < 0.001$; table 4.1.B.3).

Similarly maximum percentage of BPO operators with high BMI was presented with high RULA score than that of software engineers. The Chi-square analysis shows there is a significant association of dynamic posture on their cadre ($\aleph^2 = 10.7692$, $p < 0.005$; table 4.1.B.4). High job stress, extra work load, work urgency, poor coping ability, long hour duty and lesser payment compare to software professionals put the BPO operators in physical stress, which may be predisposed to faulty posture during work. Further, they were also motivated with extra incentives for completing an additional task in the BPOs and Software Company. The workers with high aspiration drives them to work more and stay in prolonged hours with computer as a result the operators are prone maintain poor dynamic posture. The operators need to be trained by the experts in order to maintain correct dynamic posture for prevention of possible musculoskeletal and other psychological disturbances in their life.

The high BMI computer professional tends to maintain faulty dynamic posture ($p < 0.05$; table 4.1.B.5) and they are likely to develop musculoskeletal disturbances soon in case if they continue to maintain similar posture during their work. However, none of the computer professionals secured 6 or 7 of RULA score even though, they are in the path of attaining altered posture due to their high BMI. The influence of ergonomic setup may be possible to maintain less than 7 RULA score.

Maximum 71.39% of computer workers were found having poorly maintained static (or standing) posture within the category of 5-6 RULA score, whereas 17.78% and 10.81% were in RULA score of 1-2 and 3-4 respectively (fig 4.1.B.2). Here the maximum percentage of workers found with faulty static posture due to their high BMI, thereby they maintain the altered work posture even in an ergonomic workstation with micro breaks and further deterioration may occur because of their sedentary job.

Computer workers with high BMI are likely to develop faulty dynamic (work) posture even though they are working in a developed ergonomic setup. In this study, it has been reported that the high BMI group is significantly prone to faulty work posture ($F=80426.26$, $p =<0.0001$; table 4.1.B.6).

The overweight is likely to impact on the musculoskeletal system due to prolonged or repeated defective posture in a particular position. The impact enhances the additional load on the joints or muscles which are not fully involved. Moreover, the load of stress gradually injures the tissues and cause fatigue, which results in decreased activities and finally musculoskeletal pain and related disturbances. If a warning ignored, such professionals may have serious consequences on their musculoskeletal system in the future.

In support of this study, Beers *et al*. (2008) reported in their investigation on expenditure of the passive energy increase in standing and sitting on a therapy ball compare to sitting on the office chair. This in turn implies that the energy expenditure decreases in sitting on the chair which is usually done by computer professionals during their work, and it leads to maintenance of poor posture as the body is guarded in the lower and back portion. Hence as the passive energy expenditure decreases the sitting body posture will go wrong as per their BMI.

Incorrect posture under high BMI group has been noted in this study which could be due to over bodyweight. It may contribute in faulty posture and gradually lead to physiological and mechanical load on tissues. Overweight and obesity has got definite influence on the posture in different positions, which induces functional decrement to give rise musculoskeletal pain during working period as reported by Gilleard & Smith (2007) in their study.

Sitting on an office chair is a passive kind of posture in which lesser muscle activation of the lumbo-pelvic group takes place compare to standing or sitting on a non secure sitting posture (e.g. sitting on a therapy ball). This less active lumbo-pelvic component will induce faulty dynamic posture, which may further be worse in high BMI individuals. In support of this opinion O'Sullivan *et al*. (2002) already suggested that lumbo-pelvic stabilizing musculatures are active in maintaining optimal alignment and erect posture. These muscles are less active during the adoption of passive posture in a surface electromyographic measurement of the activity of superficial lumbar multifidus, internal oblique, rectus abdominis, external oblique and thoracic erector spinae muscles on four standardized standing and sitting postures.

It has been observed that as the BMI increases the faulty dynamic posture increases with higher RULA scores. The static and dynamic posture assumed at work and during recreational activities may have adverse effect on joint structure and function. Obesity or high BMI imposes constraints on goal directed movements and high BMI individuals are not efficient as normal weight individuals, since they cannot maintain correct posture for a longer time with proper speed and accuracy of upper limb goal directed movements. This study is supported by Berrigan *et al*. (2006) in the investigation of influence on obesity on accurate and rapid arm movement performed from a standing posture.

Working for a longer duration with computers by holding the arms in 90 degree position with or without arm and back rest might lead to neck, shoulder, upper and lower back strain. In their study O'Sullivan *et al*. (2002) already reported on different upright sitting postures resulted in altered trunk muscle activation. Thoracic when compared to the lumbo-pelvic upright sitting involved less co-activation of local spinal muscles, with greater co-activation of global muscles. This result highlights the importance of postural training specificity when the arm is to activate the lumbo-pelvis stabilizing muscles in subjects with low back pain.

The load of the body exerts compression pressure over lumbo-sacral region due to body weight and ground reaction force (Khoo 1994). Computer workers spend most of the time in a fixed posture in front of the monitor. It poses the biomechanical risk on the soft tissue, mainly by the ischial tuberosities of the pelvis and their surrounding soft tissues. In this pattern of sitting (faulty dynamic posture) most of the body weight falls on the seat, back and feet. These findings support the research work of Schoberth (1962). Further the muscles along the spine undergo enormous pressure, and thus it provides faulty posture and instability to the trunk. The computer workers experience a poorly perceived pain on their back and legs. This indicates that they have a disk pressure due to prolonged sitting. Nachemson and Morris (1964) reported in-vivo disk pressure measurements of people who stood and sat without support. Their research also demonstrates that increased disk pressure means that the disks are being overloaded and will wear out more quickly (Grandjean 1988).

This study also supports the findings of Zacharokow (1988) that sitting is a dynamic activity in which subjects sit on their ischial tuberosities, which causes the pelvis to rock without sacral support to produce an anterior tilt and the sacrum rotates posteriorly bringing the lumbar spine into a flattened or kyphotic position. This is true in case of computer professionals who do close work to be too far from the surface. This requires flexion of the neck and upper body to compensate increasing stress to these areas, which gives rise to faulty and poorly maintained posture.

Interestingly, poor posture at the neck region of the computer professionals has been observed in this study. The head is held forward and increased cervical muscle activity is needed to support the weight of the head and results in muscles fatigue. Because of the increased use of computers, maximum workers are complaining of neck and shoulder pain.

In addition to the above, the external load falls on the upper limb in computer professionals, which results in constant contraction of the upper limb muscles. Due to physical fatigue and the work demands the computer professionals are forced to alter the work posture automatically.

In contrast to previous observation Ridola *et al*. (1994) reported on postural changes in the lumbo-sacral segments of the spine due to severe obesity in 28 young adults to identify the correlation existing among Body Built Index (BBI), Lumbo-Sacral Angle (LSA) and Lordotic Angle (LA). Furthermore, no correlation was found existing between LSA and LA increasing BBI; on the contrary, a correlation was evident to decrease in LSA and LA took place after reduction of body weight with therapeutic intervention. Hence in this study high BMI had a significant association with altered work posture.

5.2 BODY FLEXIBILITY OF COMPUTER WORKERS.

It was assumed that computer professionals with high BMI maintain lesser flexibility of the body. The scores of flexibility have been distributed into 7 grades, out of which 4 grades have been taken into consideration as per the available scoring report. Among computer professionals the four flexibility grades have been noted. Those grades are Poor (2), Fair (3), Average (4) and Good (5).

Evaluation of fitness and flexibility has already been studied by few investigators in Indian setups (Chatterjee and Bandyopadhyay 1993, Chatterjee *et al.* 1993, Chatterjee *et al.* 2005, Kesavachandran *et al*. 2009). As per the availability and willingness towards participation, mostly male dominated subjects were taken for this study with the age span which is appropriate for non-restricted body flexibility and active working life. In the current study association of high BMI with age, gender, cadre and flexibility of workers have been analyzed.

Upper age group (31-35) workers were seen with poor flexibility (47.18%) while compare to moderate age group (12.39%). Younger computer professionals were with average to good flexibility (37.28%), 62.71%). further the younger age group had better flexibility than the older age group. The Chi-square analysis predicts a highly significant association with age ($\aleph^2 = 184.7703$, $p < 0.001$; table 4.2.1). This may be due to the structural changes of bone, joint and surrounding soft tissues that occur as these grow old. Increased tightness of joint structure is particularly evident to the end range of motion and may interfere on coordinated movement. Loss of flexibility has been linked to degenerative changes in collagen fibers, dietary deficiencies, general paucity of movements and arthritic joint changes. Overweight or obese people are prone to have these changes which result in lesser fitness or flexibility.

In support of this finding, Brunet *et al*. (2007) in a cross-sectional study evaluated the physical fitness and body composition of children involved in the "Quebec en Forme" (QEF) and compared the data obtained from the reference values of 1981 Canada Fitness Survey (CFS). They found that BMI and Waist Circumference (WC) was negatively correlated and that this association was more pronounced in older children. Furthermore, in another study, lower physical fitness status has been seen among the age group of 55-65 by de Greef *et al*. (2006) during an assessment of health related physical fitness with help of Groninger Fitness Test (GFT) of sedentary elderly people in the Nederland. Sedentary lifestyle because of computer work in offices, BPO or IT industries has been the major drawback for fitness, which may aggravate due to over bodyweight. This may affect any age groups. For the support of this view Hancox *et al*. (2004) also noted that television viewing in childhood and adolescent was associated with overweight, poor fitness, smoking and raised cholesterol level in adulthood. Excessive viewing might have long lasting adverse effects on health.

Among the computer professionals, it has been observed that as the age goes up the flexibility reduced. The mean score of flexibility for age group 21-25 was 4.62, where as 3.66 and 2.80 for the age group of 26-30 years and 31-35 years respectively (Fig. 4.2.1). Upper age limit of 35 years has been taken in this study to ensure about the anatomical and physiological properties of joints and skeletal muscles for the flexibility. However, due to over BMI the mean score of flexibility has been seen in decreased order in this study.

Majority of male computer professionals reported with poor flexibility (37.83%) while compare to females (12.90%). Female employees were seen with good flexibility (26.88%) than the male employees (19.65%). Females were seen with a better average to fair flexibility than the males. Chi-square analysis reveals that there was a significant coalition ($\aleph^2$= 40.4285, $p < 0.001$; table 4.2.2) with gender for poor flexibility. This may be because of working women now days seen with beauty and structure conscious of have a better body flexibility and moderate body weight. In support of this view Aya *et al*. (2007)

reported that the stronger correlation exists between gender difference (boys and girls) and their percentage of body fat and BMI among Japanese children.

The physical flexibility of the employees is analyzed and seen that majority of the BPO operators had been fair (36.4%) to poor (35.6%) flexibility. Only 16.8% of the operators had good flexibility. Whereas in case of software engineers, 30.8% of them had poor flexibility and 27.2% had fair flexibility. This denotes, software engineers had a higher percentage of poor flexibility than the operators. Further, the software engineers had better flexibility (25.2%) over BPO operators (16.8%). The overall results show moderate significant ($\aleph^2$ = 11.1945 $p < 0.05$; table 4.2.3) with regard to type of employees. This could be due to the excess workload and no time for micro rest and exercise for fitness. The mean score of few BMI found to be Mean ± 4.8 which indicates low BMI workers had almost good flexibility, whereas moderate BMI workers had better flexibility (Mean ± 4.3). In case of high BMI, the workers have significantly poor flexibility (Mean ± 2.48). It could be observed that as the BMI increases, the flexibility decreases in the computer professionals. Further analysis on the level of flexibility proves that maximum number of computer professional has reduced flexibility (Mean ± 28.38) whereas a minimum number of workers have good flexibility (Mean ± 18.55; table 4.2.4). Overall flexibility appears to be average to poor in computer professionals. Overall 28.38% poor, 26.44% fair, 20.55% average, 18.55% good flexibility has been seen in the level of flexibility among the computer professionals in this study (table 4.2.5). The result of analysis of variance reveals that flexibility is highly correlated with BMI ($F = 1108.48$, $p < 0.0001$; table 4.2.6). The employees belong to all age groups and cadres that have high BMI have a tendency to develop poor flexibility. It indicates that there is a significant inverse relationship between high BMI and flexibility. This may be due to the tightness of muscles, muscle-tendon units and ligaments of high BMI workers in the sedentary job.

Apart from the adult and old age group, the fitness level has been studied in younger children, and the exact relationship has been noted. Inverse relation between BMI and fitness or flexibility already has been seen in school aged children in few earlier studies. In support of the current study, Tokmakidis and coworkers (2006) assessed health related fitness of overweight and obese Greek school children and reported regarding the stronger inverse relationship exist among overweight and fitness. Overweight and obesity is the limiting factors for fitness and performance. In their study Aires *et al*. (2008) too reported that obese and overweight children have a low physical fitness level as compared to their normal peers. In many other countries, this relationship of BMI and fitness also has been studied and found the similar result in support of the current study. Bovet *et al*. (2007) have found the strong inverse relationship between fitness and excess body weight among adolescents in the republic of Seychelles (Indian Ocean, African region).

It has been presumed that even in an ergonomic setup the computer workers have reduced flexibility due to prolonged sitting job in an air conditioned chamber in which muscles tend to go for shortening, which induces the reduction of flexibility in appendicular and axial skeletal muscles. Reduced flexibility may lead to increase muscular strain. In normal condition more efficient muscles work by which reduced fatigue occur. Whereas the postural muscles is used to support the spine and rib cage while the extremities are used to conduct work. Once the BMI increases the level of adiposity does increase in a steady manner as well as the level of oxygen uptake occurs. Ara and coworkers (2007) suggested on the level of physical activity, which has a significant effect on BMI, while maximum oxygen uptake (VO2 Max) was significantly related to adiposity. Among all physical fitness variables, VO2 Max showed the strongest relationship with BMI and fat mass. Thereby early fatigue is the prominent factor for the decrement of fitness.

5.3. WORK RELATED MUSCULOSKELETAL DISCOMFORT OF COMPUTER WORKERS.

Overexertion is the most common cause of work related musculoskeletal injuries. Workers who perform manual work are at risk for injuries to many parts of the musculoskeletal system. If the task exceeds the worker’s physical capacity of tolerance then injuries tend to occur. Job demands and worker’s capacity proportion is likely to injure the musculoskeletal system. Studies have proven that musculoskeletal disorders caused by biomechanical overload, specific types of work related exposure are associated with the development of musculoskeletal pathologies and the relative risks for certain types of occupational exposure can be extremely high (Molteni *et al*. 1996).

Evaluation of WMSD has already been studied by many authors in different Indian cities on computer professionals (Sharma *et al*. 2006, Bhanderi *et al.* 2008, Telles *et al.* 2009. The CMDQ is a highly reliable and valid tool (Hedge *et al.* 1999, Oguzhan *et al.* 2008) which has been taken here for study as well as already used in foreign (Fagarasanu and Kumar 2006, Nancy *et al.* 2004) and Indian studies (Telles *et al.* 2009) for measurement of WMSD of computer professionals. The WMSD also has been studied in various other occupations in Indian population(Gangopadhyay *et al.* 2005, Pradhan *et al.* 2007, Gangopadhyay *et al.* 2007, Gangopadhyay *et al.* 2008, Mohan *et al*. 2008, Khan *et al.* 2008, Khan *et al.* 2009, Mukhopadhyay 2009, Ghosh *et al.* 2010, Gangopadhyay *et al.* 2010, Mukhopadhyay *et al.* 2010).

In the current study, an effort has been made to find out the relationship between the high BMI and WMSD. Subjects that working for minimum 8 hours per day have been considered for finding out the body complains or discomforts (Chhabbra *et al*. (2008), Rahman and Atiya (2009).

Majority of the computer workers (49.80%) were seen with moderate musculoskeletal discomfort followed by mild discomfort (28.40%) whereas 21.80% of them experienced severe discomfort. The distribution of moderate to severe discomfort was 71.60%, which indicates an alarming situation on the musculoskeletal system.

Among the computer professionals, the respondent score was 1440 out of maximum WMSD score of 1620, whereas the average potential score of 80 out of maximum score of 90. Majority of the computer professionals (62.80%) have an upward trend in musculoskeletal disorders (40-80 potential score) only (37.20%) of the computer professionals have lessened WMSD score (< 40 potential score). It also reveals that 6.80% of computer professionals had already developed severe musculoskeletal disorders, whereas 5.40% computer professionals just experienced the discomfort. This clearly states that computer professionals do suffer from different degrees of musculoskeletal disorders. Excessive usage of the musculoskeletal system on work demands and high level of concentration on work were found to be the contributing factors to the development of these disorders. Computer operators do experience and cognize cervical pain, cramps and spasm quite frequently. Nevertheless, due to work involvement, such pain and discomfort warnings are superseded and ignored.

It has been seen that maximum number of workers under age group of 31-35 years presented with work related musculoskeletal disorders compared to other age groups. This finding supports the study of Ali and Sathiyasekaran (2006). The severity of WMSD has been seen with age group of 26-30 years and 31-35 years in an increasing order. Chi-square analysis results predict that there was a significant correlation with age group ($\aleph^2 = 183.61$, $p < 0.001$; table 4.3.1). Increasing age contributes damage to the musculoskeletal system while working with computer. Here as the age increases the capacity of tolerance of musculoskeletal exertion seems to be decreased even though there is an accommodation of WMSD to their varied work experience.

Majority of the male computer professionals suffered from moderate musculoskeletal discomforts as compared to females. In case of severity once again male (26.04%) dominate over females in manifestation of the disorder. An overall result shows that male computer professionals are highly exposed to musculoskeletal disorders than their female counterparts. Chi-square analysis predicts that there was high significance relation to gender ($\aleph^2 = 42.5618$, $p < 0.001$; table 4.3.2). Here the severity of WMSD has been seen in male workers since male dominated subjects were taken for study as well as male professionals usually take a lot of job stress as per their working time limit.

Maximum percentage of software engineers was under the mild and severe form of WMSD where as a moderate form of WMSD was claimed by BPO operators since BPO industries demand more time spent on the work, whereas software industries demand perfection and skill in producing software. Although both types of work patterns are related with computer, the operators were prone to more damage might be due to altered maintenance of dynamic and static posture. The type of work consists of frequent and repetitive force, which invariably falls on the musculoskeletal system and injures the tissues. Faulty posture contributes disturbances and thus the majority of the operators manifest work related musculoskeletal disorders. Chi-Square analysis results show that there is a considerable association ($\aleph^2$ = 10.2066, p=0.006; table 4.3.3) between cadre of employees over musculoskeletal disorder.

Influence of BMI on WMSD was analyzed by using ANOVA. The results revealed that BMI has very high significant (F = 1086.11, p< 0.0001; table 4.3.5) association with CMDQ score. The finding inferred that high BMI computer professionals are prone to musculoskeletal discomforts at work. This could be because of the body tissues are with excess stress load due to increased BMI which contribute to musculoskeletal discomforts. In support of this finding Shiri *et al*. (2008) confirmed about the association between weight-related factors and the prevalence of Low Back Pain.

With the proliferation in the use of computers, the relationship between work and high BMI has a considerable role in manifestation of musculoskeletal disorders. About three forth of all workers in industrialized countries have sedentary jobs (Grandjean 1988). This study reveals that similar proposition is found among the computer professionals with high BMI. Jobs that once had a wide variety of tasks, which allowed workers to get up from their work areas and change body positions, but this profession requires sitting for a long period. Lack of body mobility and high fat and protein food habit may contribute to increased body weight (high BMI). Sedentary work involves mostly sitting, but may involve walking or standing for a brief period of time. However, in case of high BMI workers prolonged sitting will have a definite contribution in development of WMSD. The altered posture takes place pursuant to high BMI, which reflects in neck and trunk flexion. If the head is held forward, increased cervical muscles activity is needed to support the weight of the head results in increased muscle fatigue. Because of the increased use of computers, higher BMI workers were complaining of neck, shoulder and back pain. In addition to current study, IJmaker *et al*. (2006) confirmed on an incidence of WMSD in different body parts among office workers due to long time exposure to the computers. The time factor is dependent on speed and accuracy of work which may be slow in case of high BMI computer professionals by which WMSD are more prone to be induced.

Descriptive multivariate analysis predicted that there was significant ($p < 0.05$; table 4.3.4) WMSD among computer workers in different body parts. Computer workers have experienced severe low back pain (73.576 ± 22.30) followed by neck pain (72.772 ±22.67), upper back (70.04 ± 24.70) as well as wrist joints. Right wrist joint pain was experienced more (68.631 ± 25.92) than the left wrist joint (64.622 ± 26.53). It has been observed that right hand is more frequently used while operating mouse and other activities.

Work demands for long hours of sitting before the computers with constant static contraction of the back muscles give rise to injuries to the spine and nerves. This ultimately leads to discomfort at the lower and upper back. Back pain or muscular discomfort prevents many other useful physical activities of day to day lives. It also may result in mental fatigue and depression among computer professionals. The lumbar region, in particular, this is susceptible to injuries but frequent in other regions as well. Injury occurs when the applied load exceeds the strength of particular tissue. Repetitive strain causes injuries either by repeated application of a sustained load or by application of a sustained load for a long duration (Pamela and Cynthia 2001). Static prolonged positioning has been defined as work that the muscle must perform in order to hold the body parts in certain positions. Thus static load can definitely increase the risk of cumulative trauma disorders.

The most often reported musculoskeletal discomfort is the back pain; one third to one half of VDT users report symptoms. In highly demanding jobs over three quarters of VDT users reported back pain (Smith *et al*. 1981, Sauter *et al*. 1983). The primary factor associated with back pain is seated posture that places undue loading on the spine and back muscles because of improper positioning or work posture causing isometric muscle contraction.

Computer workers with high BMI are at risk to have more work related musculoskeletal discomforts and occupational stress, because over weight may contribute in increasing of faulty posture and thereby gradually it might lead to physiological and mechanical load on tissues. Relative disk pressure is being experienced during sitting with various inclinations of the back support and presence of a lumbar support. Intradiskal pressure of the nucleus pulposus acts as a load transducer and indicates the magnitude of axial loading on the spinal column and the increased pressure indicates a greater muscular effort in maintaining the posture and hence a larger stress on the spinal column (Eastman Kodak Co. 1996). Similar studies already have been done by Hagberg (1986) regarding the muscular load on the trapezius muscle of secretaries when working at a word processing task with an electromyographic investigation using surface electrodes during VDT (computer) use. The static load on trapezius muscle exceeded recommended acceptable load level of 2% of the maximum voluntary contraction for long term work. This result confirmed to complaints of cervical-brachial pain by secretaries using VDT.

Typing is a composite task in which the arms, shoulders and trunk provide a static support base while the digits engage primarily in dynamic work. In some cases same muscles alternately engage in both types of work. In the classic typing position, elevated muscle activity has been found in the proximal musculature including the muscle responsible for shoulder elevation and abduction, forearm pronation and ulnar deviation. Pascarelli and Kella (1993) observed a number of postures used by keyboard operators who suffered from serious upper extremity symptoms. These postures included alternated thumb and hyperextended fifth digit both of which induce users to access the keyboard at potentially injurious joint angles and muscle lengths. Ulnar deviation of the wrist in excess of 20 degrees has frequently been observed and has been associated with elevated pressure in the carpal tunnel. Direct measurement of carpal tunnel pressure via a flexible pressure transducer has shown that pressure is lowest when the wrist is slightly extended and ulnar deviated.

The alterations of sitting posture before the computer may be due to high BMI, which reflects a musculoskeletal discomfort even in an ergonomic setup. To confirm this Sauter and coworkers (1991) already reported on posture related factors associated with WMSD on computer workers. In particular, low and soft seat surfaces were associated with leg discomfort, and keyboard placed above an elbow level were associated with arm discomfort as well as a high level of neck and shoulder girdle discomfort.

High BMI has a definite contribution in increasing WMSD. In support of this study Sjolie (2004) reported a significant correlation between high BMI and low back pain due to less flexibility, especially poor hip mobility.

Computer operators tend to maintain their shoulders in excessive external rotation and keep their wrist in extreme ulnar deviation for prolonged periods. They also experience discomfort at shoulder, elbow and wrist. Significant increases in muscle activity levels and amount of perceived effort are related to the position of arm and forearm during manipulation of the mouse and to the users anthropometric characteristics.

The second order of discomfort experienced by the computer professionals are pain and discomfort at the gluteus region (56.746 ± 30.92) and the forearms. Right forearms (49.948 ± 29.50) pain is well perceived than the left forearm (44.775 ± 28.84).

Sitting for a long period of time even on the comfortable chair leads to ischemic compression of blood vessels and nerves in the gluteus region. At the beginning, the computer professionals may perceive vague pain at the gluteus muscle and get adapted to the remaining period of the work but later may experience severe pain and discomfort. Further, prolonged work with computer may develop pain at the forearm muscles. Right forearm is over exerted than the left forearm due to typing and working on mouse, mostly with the right hand.

Mechanical discomfort caused by direct pressure exerted on the base of the palm can contribute to development of cumulative trauma disorders. The cubital tunnel syndrome with subsequent ulnar neuropathy is caused by a worker chronically leaning on his or her elbows on desks, armrests or hand surfaces during working. Sustaining the elbow in a position of prolonged flexion and elevated the task of ulnar nerve compression and thus increased susceptibility of the cubital tunnel syndrome.

Although computer operators experience pain and discomfort in almost all parts of the body the third order of pain and discomfort are experienced at lower leg and the left knee joint found to have less affected. Left lower leg (16.304 ±19.18) followed by right lower leg (17.426 ± 19.83) are least affected, whereas the left knee joint (22.576 ± 21.61) appears less affected than the right knee joint. This could be because of all subjects were right hand users.

However, in a developed ergonomic setup the musculoskeletal discomfort has been seen more among computer professionals with high BMI. Constant pressure and exertion for the longer period of time among high BMI computer workers have been contributed to various musculoskeletal discomforts even though they take micro breaks during their work period as well as in an air conditioned environment.

5.4 OCCUPATIONAL STRESS (OCCUPATION RELATED PSYCHOSOCIAL STRESS) OF COMPUTER WORKERS.

Occupation related psychosocial stress among working population is drastically increasing worldwide. Stress at work has become an integral part of everyday life. OSI developed by Srivastava and Singh (1981) has been commonly used for research in Indian industries Vempati and Telles 2000, Jain *et al*. 2007, Adhikari 2008, Kumari 2008, Bakshi *et al*. 2008, Kumar and Singh 2009, Sarikwal and Kumar 2010. Psychosocial stress has been linked to jobs that include rigid work procedures, lack of social support, monotony and insecurity. In this study psychosocial factors have been checked among computer workers from a single socioeconomic status (i.e. upper I; Kupuswamy 1981, Mishra and Singh 2003, Kumar *et al.* 2007) with high professional qualification, high earning and well to do family background. It helped in unbiased assessment of occupational-psychosocial stress claiming the impact of different BMI, since there were no other levels of socioeconomic status included.

Computer professionals are prone to various types of occupational stress in the modern corporate world. The work demands certain goal, milestone and accomplishment with perfection and its related consequences in the card are kept in mind. This particular profession in the recent past is the boomerang among the young people. The stress was laid on work accuracy to complete the project and longer working hours for a bigger task. Moreover, night shift may not be averted for female employees.

Several reports have linked psychosocial stress not only to an increased incidence of low back pain but also increased loss of work time associated with low back pain (Smith *et al*. 1981). The physiological mechanism associated with the development of pain includes increase muscle tension and metabolic changes, which alter biochemical processes at the cellular level. In addition to physiological changes, stress often induces behavioral changes such as the amount of force used during keying, increased tension in shoulder muscles and/or back muscles, absenteeism as well as an increased tendency to report problems to seek professional assistance. Stress has also been linked to jobs that include rigid work procedure, lack of social support, monotony and insecurity. Many individuals in these jobs also express their dissatisfaction with their position (Mary and Christin 1996). In this current study, an effort has been made to find out the relationship between the BMI and Occupation related psychosocial stress.

The influence of age on occupational stress was analyzed and observed that younger age group (21-25 years) has perceived the highest percentage of moderate stress (62.71%) as compared to older age groups (52.06%, 53.43%). In case of severe occupational stress category older age group perceived increased percentage of stress (37.18%) than the youngest age group (0%). Research findings established that the stress can start at any age (Bittman 1999) but especially occupational stress remain peak at 50 years and gradually decrease depending on the type of job (Health day News 2009). Physiological and psychological fitness stared declining from the age group of 40 years and above. The present study inferred that due to strenuous working condition and overload of work among computer workers, it accelerates ageing and stress which in turn decline the psychological fitness even below the recommended age. The Chi-Square analysis of association showed that age factors were significantly associated with occupational stress ($\aleph^2 = 79.8015$, $p < 0.001$; table 4.4.1). The younger computer workers experienced moderate degree of stress as their age increased the occupational stress also increased, which is much earlier than the normal human being experiences. In contrast Chandraiah *et al.* (2003) reported a negative correlation exist between age and occupational stress among industrial managers.

Similarly, occupational stress was significantly associated with gender ($\aleph^2$= 27.4373, p< 0.001; table 4.4.2). Particularly male computer workers perceived moderate level of occupational stress (78.23%) as compared to females (21.77%). Male workers (95.55%) have been found with an increased level of severe stress over their female counterparts (4.44%). This may be because of male workers sustain to longer and harder task than females as well as the study has been taken on male dominated computer professionals. The male worker's body structure and muscle functions are quite capable enough in sustaining strenuous works as compared to females. Usually the women are more stressed and depressed compare to men from early age in their day to day life (Hammen and Mazure 2003), but here the male workers were found more stressed could be due to the bigger task and longer working hours.

Programming at software industries is an extreme reward earning job in present scenario. Every youngster wants to take this profession for their better future. Better earning puts more job stress than operators in BPO industries. In this study occupational stress was associated with the different cadre of employees ($\aleph^2$= 9.2951, p< 0.001; table 4.4.3). The constant strain in work and type of job demand, the computer professionals at BPOs could not cope with the job. The moderate stress has been seen in higher percentage among BPO operators (60.4%) than computer engineers (48%). The severe incidence of occupational stress among the computer engineers (28.8%) in the software companies could be due to increased psychological pressure on formulating software within the given time while compare to 25.2% of BPO operators with moderate analytical and typing job.

It has been seen that role overload (22.92± 6.882), strenuous working conditions (13±4.668) and the unreasonable group pressure (11.958±4.970) and role conflict (11.354±3.751) seem to be influencing psychosocial stress among computer professionals whereas low status (6.716 ± 2.449), unprofitability (6.436±2.810) found to be least factors contributing to stress. Although computer professionals are better satisfied on their profitability and social status but working climate found to be intolerable woes on them. Responsibility in their work (10.436±4.281), under participation (9.856±1.842) and poor peer relation (9.446±1.829) play a moderate trend in influencing occupational stress. Descriptive statistical analysis shows significance ($p < 0.05$; table 4.4.4) in all the variables of occupational stress.

In this study occupational stress was significantly associated with BMI ($\aleph^2 = 522.6322$, $p < 0.001$; table 4.4.5). As the BMI increases the moderate stress score also increases. Mild stress has not been ignored here for the purpose of identifying an actual level of stress. However, this mild stress in due course may gradually increase to moderate and severe stress. If such stress is not prevented in IT sectors the employees may face a decline of performance due to musculoskeletal pathologies, which lead to absenteeism in work. High BMI group of workers may not cope with the speed and accuracy of the task, and they may take longer time thereby this could put them in severe stress than that of moderate and low BMI workers. In support this study Ostry *et al*. (2006) have reported the similar result of association between psychosocial working conditions and high BMI among men and women.

Due to high BMI many disturbances may occur in body towards the stress as well as high BMI and stress contribute to have the different biological malfunction which may affect in workers performance in any kind of physical and mental stressed job. With increase of BMI, the glucocorticoids are less able to inhibit TNF-alpha production following stress (Wirtz 2008). Furthermore, in an animal study, obesity predisposes the myocardium to oxidative stress and is associated with elevated myocardial enzyme activities (Vincent 1999).

In contrast of this study, Kouvonen *et al*. (2005) found that aggravated scores of lower job control, higher job strain and higher effort-reward imbalance were associated with a higher BMI, but the relationships were weaker than those obtained with the aggravated score. However, in the current study few occupational stressors (role ambiguity, role overloads, responsibility, role conflict, strenuous working condition, low status, poor peer relation, under participation) were seen effectively associated with high BMI.

Occupational stress is quite common in most of the job in modern days. Some of the job which demands perfection overworks and concentration decreases the stress tolerance. Though we have a natural coping up process, if one point of tolerance limit we may break down as in case of young modules stress on metallic wire. A human being also has some limitation in adjustment to the stress. High BMI computer workers are prone to varieties of psychosocial stressors in all directions and their high BMI status were significantly associate with occupational stress ($F=3081.82$, $p<0.0001$; table 4.4.6).

The employers met the basic food and beverages to high calorie diets as well as other needs of the employees as a result there could be increased BMI. Overweight and obese workers tend to be in a stressful state from high job demand and low job attitude in the workplace and such stressful condition affects their eating behavior. They tend to eat much, which contributes to obesity (Nishitani and Sakakibara 2006). In other words stress-induced eating may be a factor contributing to development of obesity (Torres and Nowson 2007).

There are 12 factors of occupational stressors, which have been identified in an organizational climate. The computer workers have shown mild to severe degrees of stress in those 12 stressors. They are under pressure even from the friends and group (different culture) on various ways such as unity, sharing of work and even spending money on their groups. Perception of occupational stress is more common among high BMI workers than that of low BMI. It has been used to add additional stress variable to the equation as given in research design to determine whether the prediction can be made more precisely. For each stress variable, there is a corresponding slope which is referred to multiple regressions as 'b' weight, for entire equation, there is one intercept, which is referred to as the constant. A stepwise Regression-strategy was adopted combining forward and backward procedures to generate an equation and to predict more accurately the actual occupational stressors among computer professionals. It has been observed that occupational stress was significantly correlated with high BMI computer professionals ($p<0.001$) and the male professionals are prone to a lot of occupational stressors (p<0.002), in the area of Role ambiguity (p<0.001), Role overloads (p<0.001), Responsibility (p<0.001), Powerlessness (p<0.04), Role conflict (p<0.001), Strenuous working condition (p<0.001), Low status (p<0.001), Poor peer relation (p<0.001), Under participation (p<0.001).

The remaining biographical variables (age group, type of job, type of company) and OSI variables (group and political pressure, intrinsic impoverishment and unprofitability) were not significantly correlated.

Stepwise multiple logistic regression analysis was done on all the variables such as dynamic posture, flexibility, work related musculoskeletal discomfort, occupational stress and other biographical variables. From that analysis (table 4.4.8) it was inferred that computer professionals did have faulty posture (p<0.001) which resulted in work related musculoskeletal discomfort (p<0.001), occupational stress (p=0.058) and flexibility (p<0.001; table 4.4.10). All the above body disturbances did occur due to high BMI (overweight and obesity). Older age groups were prone to various discomforts and disorders, and it occurs more commonly among male computer professionals. The present study found that high BMI was significantly associated with posture, flexibility, musculoskeletal discomforts and occupational-psychosocial stress (p<0.0001).

To predict precisely the influence of faulty dynamic posture on BMI, occupational stressors and other biographical variables multiple logistic regression was performed and found that faulty dynamic posture was very highly associated with higher BMI group (F = 4523.96, p < 0.0001; table 4.4.9), higher age group and other occupational stressors such as under participation in the organizational demands (p=0.0003) and they have tremendous occupational conflicts with regards to personal discomfort v/s work demands (p<0.001). Computer workers have very high responsibility in industry, where the given task has to be performed in time with accuracy (p<0.001). Although, they do not have any power in the organization (p<0.001), apart from the income are not profitable (p<0.001) in BPO industry compare to their work. Computer workers are prone to strenuous working condition (p<0.001) in the organization, which causes various psychosocial problems, which brings down to low status (p<0.001). Moreover poor peer relation (p<0.088) were also one of the contributing factors for manifestation of psychosocial stress. Age factor also influences in occupational stress (p<0.001), older the age group higher the faulty posture and occupational stress among the high BMI computer professionals (p<0.001).

Multiple logistic regression analysis has predicted that poor flexibility was very highly correlated with high BMI, occupational stress and other biographical variable (F = 437.22, p < 0.001; table 4.4.10). Overweight (p < 0.001) found to be significantly associated with flexibility as well as older the age group poor the flexibility (p<0.001).

Multiple logistic regression analysis has predicted that musculoskeletal discomfort was very highly associated with BMI and some psychosocial/occupational stressors in organizational climate (F=332.15, p<0.0001; table 4.4.11). Computer professionals (p<0.001) of increased age groups (p=0.002) and especially engineers/operators (p<0.001) working in industries have experienced musculoskeletal discomforts of upper parts of the body. Overall strenuous working conditions (p<0.001), overload of work (p<0.029), increased responsibility found to be additional contributing factors for manifestation of musculoskeletal discomforts among computer professionals. Apart from this, the operators working in BPO companies are prone to have increased musculoskeletal discomforts caused by biological overload and specific type of work related exposure were associated with musculoskeletal discomforts. The present finding has predicted that such musculoskeletal discomforts were associated with BMI and occupational-psychosocial stress.

Finally, from the correlation co-efficient between BMI and other variables it has been found that BMI is positively correlated to dynamic posture (0,99), work related musculoskeletal discomfort (0.89), occupational stress (0.92)and negatively correlated to flexibility (-0.85).

From the above, it has been observed that high BMI computer workers were prone to faulty dynamic (work sitting) posture, increased work related musculoskeletal discomforts, occupational stress and reduced flexibility. Hence, the alternative hypothesis has been accepted.

LIMITATION OF THE STUDY:

1) The present study confined to the Indian IT & BPO company's culture and the pattern of IT administration.

2) This study was done in natural setting of the time of the research scholar visit. Therefore, there could be mild altered state of posture subconsciously.

3) This study might not be fully averted to self response bias of the respondents.

4) Age limitation of a minimum 21 and maximum 35 years was considered.

5) Male dominated population of sample due to the voluntary interest for participation.

DELIMITATION OF THE STUDY:

1) Standing posture measurement was taken only for the consideration of prevalence of correct posture among them.

2) Lower back and Hamstrings (Bilateral) only was assessed for the flexibility measurement.

3) Body discomfort assessment was limited to the musculoskeletal system.

SUGGESTION FOR FURTHER STUDY:

1) Equal number of male and female population can be taken for the study.

2) Standing posture can be checked with pre and post study to find out the influence of high BMI.

3) Upper limb flexibility can be assessed to find out the influence of high BMI.

4) Visual problems can be taken into consideration along with the musculoskeletal system.

5) Mental stress can be added along with occupational-psychosocial stress.