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AN ON-LINE INTERVENTION TOOL FOR REDUCING MUSCULOSKELETAL DISCOMFORT AMONG INDIVIDUALS WORKING WITH COMPUTERS AND LAPTOPS FROM HOME

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ABSTRACT **Background:** With the increasing use of computers, laptops and hand-held communication devices globally among office employees, creating awareness on office ergonomics has become a top priority. Emphasis needs to be given on maintaining ideal work postures, ergonomic arrangement of workstations, optimizing chair functions, as well as performing desk stretches to reduce musculoskeletal discomforts arising from the use of these equipment, thereby promoting safe work practices at offices and home, as in the current scenario many employees work from home with flexible work hours. Hence, this justifies the importance of our study. **Objective:** To promote safe working by exploring An On-line Intervention Tool to achieve behavior change at distant sites when an on-site visit may not be feasible. **Materials and Methods:** An invitation was sent by the investigator to habitats of three different urban housings in Kolkata to take up an online Nordic questionnaire, a screening tool for musculoskeletal symptoms, shared in local languages on two occasions – baseline evaluation (n = 252) and a follow-up evaluation after 3 months (n = 252). After completing the baseline questionnaire, employees were immediately trained on correct postures and office ergonomics with animation graphics. The same questionnaire was sent again after a 12-week gap only to those employees who responded to the baseline questionnaire on initial assessment. **Statistical Analysis Used:** Data collected were analyzed using the Statistical Package for the Social Sciences (SPSS) version 20.0 software and variables were compared using odds ratio as well as Chi-square test. **Results:** Of the 252 respondents 54.6% had some musculoskeletal symptoms. Among them 65% had lower back pain, 56.7% had upper back pain, 61.8% had wrist pain, 53% had shoulder pain, and 45.6% had knee pain. The percentages are high as some participants had multiple complaints i.e. 2 or 3 complaints. However, only 38% of these respondents had ongoing symptoms at the time of evaluation (past 7 days). A subsequent 3-month evaluation after web-based intervention showed a significant 45.6% to 24%, % decline in ongoing symptoms. **Conclusions:** We conclude that newer technology using web-based animation graphics is a highly efficient technique to create office ergonomics awareness and has the potential to become a best practice in countries where language is a communication barrier and an on-site visit may not be feasible due to meagre resources.

KEYWORDS : Intervention, musculoskeletal disorders, KAP, office ergonomics

INTRODUCTION:

The widespread introduction of computing technologies into the office workplace has transformed the modern offices of today, thereby promoting agile working. The availability of equipment that is no longer used, sitting at a desk in a dedicated office (like laptops, tablet computers along with internet-capable smartphones) has also resulted in radical developments and has posed a challenge pertaining to where and how that equipment is used, removing the constraints of the conventional office environment thereby paving the way for novel ergonomic office designs. Evidence suggests that these changes in technology and work practices still present risks to health and safety; but the nature of these risks (both physical and psychosocial) and the requirements for managing them, are gradually changing as a result. Researchers have attempted 'pattern syntax' principle in reaching the target from different perspectives. [1,2] Hence this approach has been applied in the current study to achieve objectives of this study.

Keeping in pace with the advancing technologies and protecting the office workforce from hazards of work related musculoskeletal disorders (WRMSDs) due to unergonomic ways of working with above mentioned equipment, there is a dire need to explore cost-effective as well as innovative intervention options for safer working.Although there is a high interest shown in improving workplace conditions, there are very few longitudinal field trials that focus on the ergonomic interventions for individual health of staff and productivity.[3]This further justifies the need to undertake this relevant research study.

Currently, musculoskeletal discomforts is one of the most important problems ergonomists have been encountering in workplaces globally.[7,9] In many countries, prevention of work-related musculoskeletal disorders has been considered as a national priority.[5,10] The published scientific reports and papers show that the incidence of musculoskeletal disorders among computer users is much more than in other occupations. [4]

Poor postures have been found to be associated with decreased performance efficiency, due to the body discomfort resulting from restricted postures. More suitable working postures may have a positive effect on workers' musculoskeletal systems and may allow for more effective control of work performance and reduction in the number of occupational injuries.[6]Awkward and constrained postures result in musculoskeletal stress on different body regions of seated workers[7] and are a major factor in the development of musculoskeletal disorders.[11,12]In India, WRMSDs tops the list of occupational health morbidities' and very few studies have been undertaken to explore the most effective ergonomic interventions to reduce WRMSDs and injuries.[13]

The goal of ergonomics is to reduce stress and eliminate injuries and disorders associated with the overuse of muscles, bad posture, and repeated tasks associated with the use of computers. Awareness on safe working postures also helps in grossly reducing the morbidity of work-related musculoskeletal disorders, and hence this justifies the focus on awareness creation that has been undertaken in the current study based on principle of 'pattern syntax.'

MATERIALS AND METHODS:

The study involved participation of habitats of three different urban housings in Kolkata, West Bengal, India who were directly or

indirectly using **computers and laptops from home. Total study subjects from three housings were 72, 94 and 86 (total 252) respectively.** Formal consent was taken from all the participants prior to study. Data was collected from the participants using 13-point Questionnaire including Nordic questionnaire - a screening tool for musculoskeletal symptoms, that was prepared in local languages as well as in English on 2 occasions – baseline and after 3 months. This pre-tested Questionnaire was very simple and took approximately 6 to 8 minutes for completion.

The Questionnaire was based on workplace and behavioural factors mentioned below, such as:

a) Equipment and workstation,
b) Working posture,
c) hours of work,
d) hours of sitting time, and
e) Psycho-social factors including stress.

Non modifiable risk factors like age and sex were also included in the questionnaire.

After completing the questionnaire participants were trained on correct postures and office ergonomics with animation graphics (intervention). The animation graphics were programmed to initially show incorrect postures and subsequently the correct postures that need to be maintained during working with computers/laptops and related devices (kindly refer to graphics 1a, 1b, 2a, 2b, 3a, 3b depicting still photographs of animation graphics). The participants appreciated the animation graphics and were impressed as it was a 'never-before experienced' fun learning. The approximate time taken to view all the animation graphics was again 6 to 8 minutes. As participants appreciated all the animation graphics, they viewed them for longer time periods.

The data was again collected using the same questionnaire after a gap of 12 week for post evaluation.

RESULTS AND DISCUSSION

Placement of monitor screen, keyboard, mouse along with type of furniture and related equipment may all involve risks as out of 252 participants, 54.6% had some musculoskeletal symptoms. Among them 65% had lower back pain, 56.7% had upper back pain, 61.8% had wrist pain, 53% had shoulder pain and 45.6% had knee pain. The percentages are high as some respondents had multiple complaints i.e.2 or 3 complaints. However, only 38% of these respondents had ongoing symptoms at the time of evaluation (past 7 days). The current study revealed that amongst the respondents working more than five years the prevalence of musculoskeletal discomforts was high (34.92%) compared to the participants working less than five years (14.29%), $p<0.001$ (Table-4). Respondents working more than five years may be more susceptible to injury under high work demands, as wear and tear of the body (especially of joints) along with age- is an important individual risk factor inducing musculoskeletal discomforts s. The current study also revealed that women were having more musculoskeletal discomforts (58.36%) compared to men (49.54%). This finding is in accordance with other studies whereby women have been reported as having a higher incidence of musculoskeletal discomforts (NRC, 1999; EU-OSHA, 2013). [2,14] Women are for instance more often exposed to repetitive biomechanical stresses of the upper limb more than men. Also, the complex interplay between anthropometrics, work ability, productivity, and pain perception, may explain gender differences. Explanations for the higher incidence among women can also be found in differences in household work and childcare, work situation, physical and psychosocial work conditions (Wahlstrom, 2005) [8] A study among 690 Danish computer users for instance revealed that women often report poorer work ability and differences in pain perception than men (Madeleine, 2013)[16]

Hours of work determines the cumulative biomechanical load and degree of fatigue, it can be short and intense, leading to acute disorders, or prolonged with low/moderate intensities, leading to chronic or degenerative disorders. Prolonged sitting posture during VDU work could initiate continuous static contraction of the neck muscles, which may result in muscle overload, resulting in neck pain (Wahlstrom, 2005), [5,14] upper limb disorders and back pain. Moreover, the general health risks of prolonged sitting time are becoming increasingly evident. Large epidemiological studies have shown that total sitting time is associated with increased risk of all-cause, cardiovascular and possibly cancer mortality. Especially an increase of all-cause mortality can be noticed around 7 or 8 hours of self-reported sitting time per day (Van der Ploeg et al., 2015) [17] In the current study the symptom of musculoskeletal discomforts was higher in participants' whose hours of sitting work was 4-4.7 hours (62.50%) compared to other participant whose hours of sitting work was 2-4 hours (48.20%), $P<0.001$ which is significant. When workers are stressed, their muscles are more contracted than normal and cannot relax completely at rest. Stress increases the occurrence and changes characteristics of musculoskeletaldiscomforts, increases pain, and makes operators more susceptible to other risk factors.

A subsequent 3-month evaluation showed a significant 41-50% decline in ongoing symptoms. This decline was attributable to the following behavior changes observed in the trained participants' post-intervention viz., a) approximately 76.4% participants could arrange their workstation ergonomically, as against 12.6% pre - intervention. b) approximately 85.5% participants performed desk stretches, as against 8.6% pre - intervention and. A striking 97% participants reported animation graphics were educative and motivating (Graphics1a, 1b, 2a, 2b, 3a, 3b).

Animation Graphics on Office Ergonomics used as training intervention;

Few simple animation graphics used in the current study (shown above) were programmed to initially show incorrect postures and subsequently the correct postures that need to be maintained during working with computers/laptops and related devices which influenced behavior modification

More than 50% of the respondents belonged to the age group 18-30 years Female respondents were also higher i.e. 57.6%.

After the intervention (post-intervention),it was observed that there was higher reduction in symptomatology of musculo-skeletal discomfort. Knee pain reduced from 45.6% to 24%, lower back pain (LBP) reduced from 65% to 32.8%.Upper back pain (UBP), wrist pain and shoulder pain also reduced to 29.7%, 22.5% and 36.3% respectively (Figure-1a).

Respondents also changed their habits of connecting separate keyboard and mouse to their laptop It was also seen that participants also arranged their workstation ergonomically for safer and comfortable working. Behaviour changes in - connecting separate key board and mouse increased from 18.8% to 86.2%, -arrangement of workstation ergonomically improved from 12.6% to 66.4%. Odds Ratio = 5.28(Figure-1b)& Table 3.

There was a striking improvement in the habit of supporting the lower back during work hours and performing desk stretches twice a day, thereby signifying the usefulness of the study in achieving the study objective. This is evident by the finding that 78.6% participants supported their lower back post-intervention as compared to 12.7% in pre-intervention study. Approximately 85.5% participants performed desk stretches twice a day compared to 8.6% in pre- intervention study (Figure 1c) $p< 0.001$.

It was also observed in the study that female participants were experiencing more Musculo-skeletal discomfort compared to men as there was higher reporting of wrist pain, followed (in order) by low back pain, knee pain, upper back pain and shoulder pain. The study conducted by Van Der Ploeg, et al 2015 showed similar findings. [9] (Figure 1d).

Participants spending more time in sitting work reported as having more Musculo-skeletal discomfort as compared to participants spending less time in sitting work (Figure 1e).

A strong relationship between musculoskeletal problems and hours of sitting was observed (Table-1). Relation between different musculoskeletal problems and the habit of supporting the back during working was also observed as having a strong association (Table-2). Also, the habit of connecting separate keyboard and mouse to their laptop and development of musculoskeletal problems was also correlated (Table-3).All the above were statistically significant findings, as mentioned earlier.

In short, all above results of the current study reveal that the intervention viz, web based on-line questionnaire and subsequent training with animation graphics was extremely successful in significantly influencing behaviour modification towards pro-active

and practical office ergonomics. The participants adored animation graphics and admired the training that was imparted. They agreed to become trainers (TTT) /ambassadors to influence behaviour modification amongst their fellow colleagues on maintaining ideal work postures, ergonomic arrangement of workstations, optimizing chair functions as well as performing desk stretches thereby promoting safer working.

Conclusions: As the above results are highly gratifying, the evaluation appears to be an excellent, cost-effective technique based on the principle of 'pattern syntax'{using various modalities to achieve a common end-objective}, that brings about desired behavior change in ideal work-posture maintenance . For sustainable behavior modification, this training activity could be repeated at 6 monthly intervals with short, intermittent reminders for safer working. Hence, we conclude that newer technology using animation graphics is highly effective to create ergonomics awareness and has the potential to become a best practice (because of its ready acceptance amongst participants') in countries where language is a communication barrier and an on-site visit may not be feasible in the current scenario of budgetary constraints globally.

Figure 1a : Distribution of respondents according to having history of different types of musculo-skeletal discomfort (multiple response)

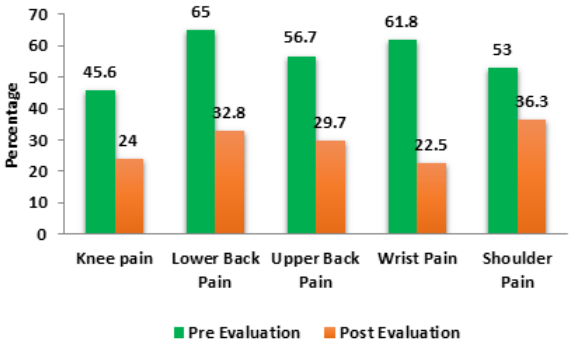


Figure 1b : Distribution of respondents according to the habit of connecting separate keyboard and mouse to their laptop and arrangement of workstation ergonomically for safe, comfortable working

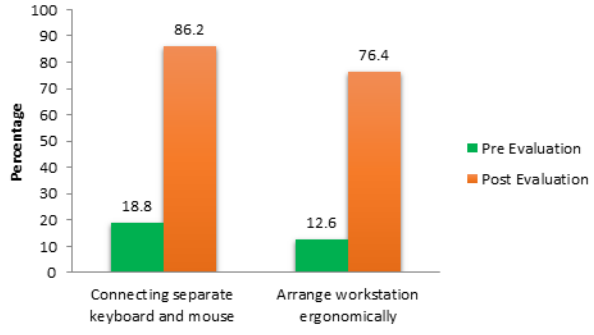


Figure 1c : Distribution of respondents according to the habit of supporting their lower back during work as well as habit of performing desk stretches twice a day

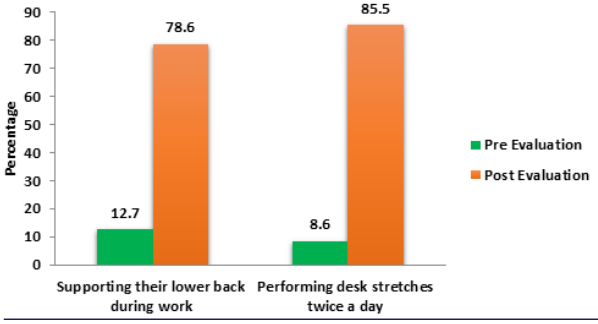


Figure 1d: Sex wise distribution of respondents with MSDs (n=252)

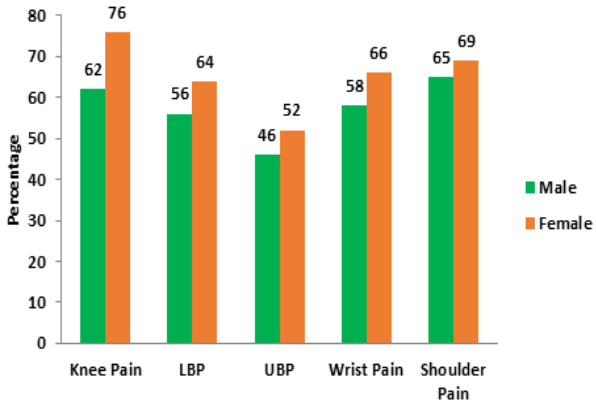


Figure 1e: Distribution of respondents showing correlation between Hours of sitting at work and development of symptomatology of MSDs (n=252)

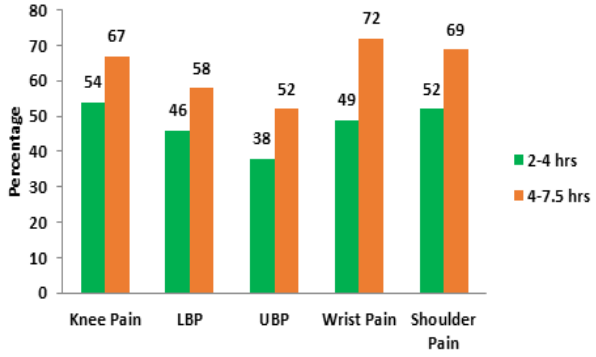


Table 1: Comparison between different musculoskeletal problems and hours of sitting

Musculoskeletal problems	2-4 hours sitting		4-7.5 hrs sitting	
	Number	%	Number	%
Having musculoskeletal problems	140	55.56	188	74.60
No musculoskeletal problems	112	44.44	64	25.40
Total	**252**	100.00	**252**	100.00

Pvalue<0.001 (Significant)

Table 2 : Comparison between different musculoskeletal problems and their habit of supporting their back during working.

Supporting back during working	Having musculoskeletal problems		No musculoskeletal problems		Total number	
	Number	%	Number	%	Number	%
Support taken	32	12.70	128	50.79	160	63.49
Support not taken	92	36.51	0	0.00	92	36.51
Total	**124**	49.21	**128**	50.79	**252**	**100**

Pvalue<0.001 (Significant)

Table 3: Comparison between different musculoskeletal problems and their habit of connecting separate keyboard and mouse to their laptop.

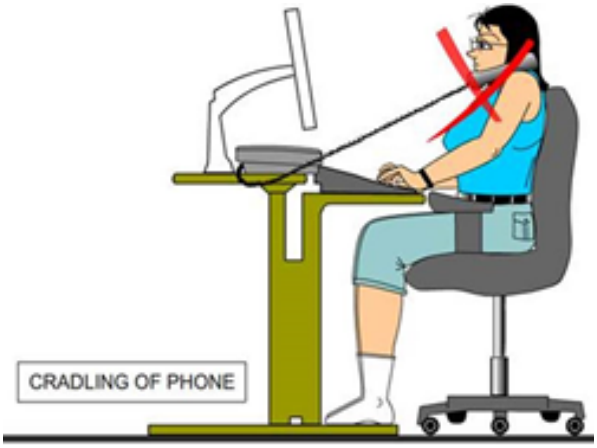
Connecting separate keyboard and mouse to their laptop	Having musculoskeletal problems		No musculoskeletal problems		Total number	
	Number	%	Number	%	Number	%
Yes	6	2.38	98	38.89	104	41.27
No	144	57.14	4	1.59	148	58.73
Total	**150**	59.52	**102**	40.48	**252**	**100**

Odds ratio = 5.28

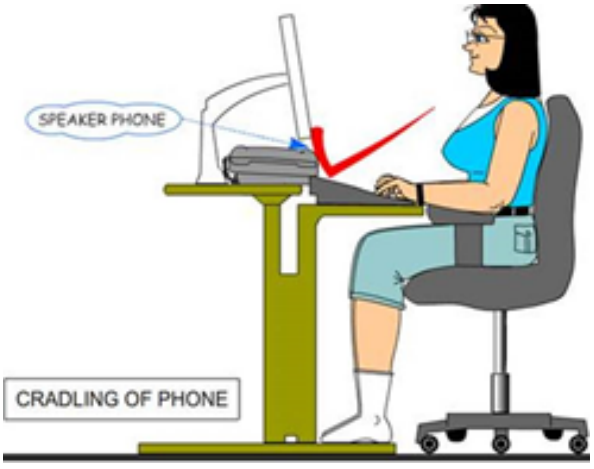
Table 4: Comparison between prevalence of musculoskeletal disorders between respondents working for less than five years and more than five years.

Working years	Prevalence of MSDs		No prevalence of MSDs		Total	
	Number	%	Number	%	Number	%
participants working less than five years	36	14.29	64	25.40	54	36
participants working more than five years	88	34.92	64	25.40	198	88
Total	124	49.21	128	50.79	252	124

Pvalue<0.001 (Significant)

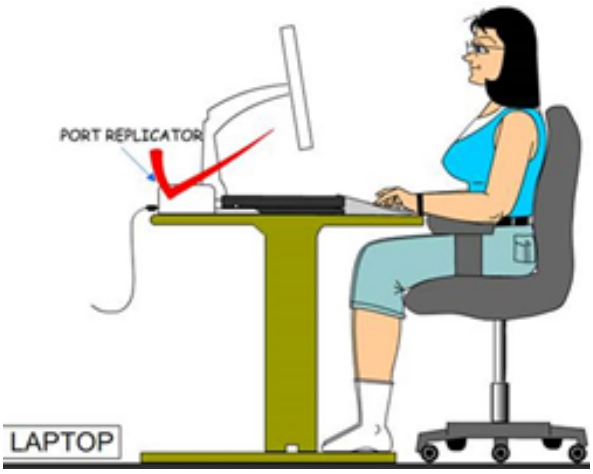


Graphic 1a



Graphic 1b

Graphic 2a



Graphic 2b

Graphic 3a

Graphic 3b

Graphics : Animation Graphics on Office Ergonomics used as training intervention

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