International Journal of Medical and Health Sciences

Journal Home Page: http://www.ijmhs.netISSN:2277-4505

Original article

Do We Practice What We Know? A Study Comparing Ergonomic Practices

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ABSTRACT

Background: The increasing use, necessity and negligence to handle computers in every specialty of life have raised important health concerns. In the absence of any formal ergonomic education in the country the study was aimed to compare the awareness and practices of ergonomics between groups of individuals with and without any ergonomic awareness. **Methods:** A questionnaire based cross-sectional study was conducted to compare the awareness and practices of ergonomic principles. Group I comprised of professionals from different occupations like doctors, Information technology professionals (IT), bankers, marketing individuals and teachers with some form of ergonomic education. Group II comprised of computer science students who had no such education. Responses were compared by chi square test with $p < 0.05$ significance. **Results**: Group I had 318 responses and group II had 198. Participants from group I had significantly more information and better practices than those in group II regarding certain ergonomic standards, height of chair p=0.001, seat pan p=0.002, computer screen filter p<0.001, arm rest p=0.0002, position of wrist p=0.0171, elbow position p=0 and back rest p=0.0016).Safer practices were far less than the level of information in either group showing a wide gap between theory and practices. **Conclusion:** Ergonomic practices were better in those who had some awareness suggesting the need of an organized ergonomic design for all computer users complemented with structured awareness sessions and a strategy to remove the gap between theory and practices.

KEYWORDS: Ergonomics, Work related musculoskeletal disorders, Musculoskeletal symptoms.

INTRODUCTION

The word Ergonomics is a Greek word meaning - "laws governing work" which looks at the application of this known yet un-practiced science both physiologically and psychologically [1]. The International Ergonomics Association defines Ergonomics as, "the scientific discipline concerned with the understanding of the interaction among humans and other elements of an organization or a system and the profession that applies its application, theory, data and methods to design in order to optimize human wellbeing and the overall system performance" [2]. Ergonomics is the art of designing the job, equipment and workplace suitable to fit the workers comfort needs [3]. Poor comprehensions about healthy computer use and inappropriate application of ergonomic beliefs end up in computer-related health problems for its end users [1]. Thus, it is imperative to organize the workplaces for this contemporary equipment as well as create awareness about healthy computer usage and its applications [4].

Suitable design of workstations with equipment adjustable to meet individual requirements mainly computer chair, display screen and key board can prevent onset of a number of problems. It is understood from studies that at ease posture requires feet resting comfortably on the floor or on a foot rest; knees slightly lower than hips with two to four inch gap between the back of knees and the front edge of the chair when the back is against the chair[5].Computer users also should have adequate space to stretch legs so as to

prevent leg injuries[6] It is hypothesized that perceived muscular tension is an early sign of work related musculo-skeletal disorders (WMSD) arising from work directorial and psychosocial factors as well as physical load and individual factors [5].

Globally there has been a 25% increase in number of people suffering from work related musculo-skeletal disorders (WMSD) over the last 10 years contributing to at least 2% of the universal health problems. With the emergence of multiple musculoskeletal problems arising from poor awareness of computer usage-related health securities, the awareness of ergonomics has gained immense importance [7, 8].

The risk of developing WMSD is due to unsuitable design of work station, inappropriate postural stance during sitting and failure to adopt healthy self-care behaviors like changing while at work [9]. Theoretically, we know that prolonged sitting without breaks leads to poor regional blood circulation, stiffness of joints and pain in various regions of the body and increases the chance of repetitive strain injuries, visual damage and long term disability [7,10,11].

Computer related health issues are not restricted to any specific profession[2, 12,13].It is therefore imperative that Ergonomic specialists recognize the common implications of ergonomics at work places so as to gratify the stake holders and also prevent associated musculoskeletal disorders and chronic disability leading to a decrease in health disorders globally[12,13,14].

This study is aimed to compare the awareness and practices with respect to design of work places between two groups of computer users; students who use it as an essential educational tool and occupational/professional groups who manage its use to earn their bread and butter. Although a vast number of students and professionals make effective use of computers yet the practice of ergonomic principles in many domains is missing and is underdeveloped in our country.

MATERIALS AND METHODS

It was a comparative, cross-sectional study conducted in four weeks time period to compare the awareness and practices of computer users between a diversified group of professionals with a group of students enrolled in Bachelor of Science Computer Science Program at Bahria University-Karachi Campus. The permission was acquired from Ethical review Board of Bahria University Medical & Dental College (reference no: ERCO 012/09).

A questionnaire of ergonomics was tailored from "Easy Ergonomics for Desktop Computer Users (prepared for publication by the Cal/OSHA Consultation Service, Research and Education Unit, Division of Occupational Safety and Health, California Department of Industrial Relations)[15]. Random selection of professionals at various professional organizations and institutes like doctors, IT (Information technology)persons, bankers, marketing individuals and teachers who reported to have some form of ergonomic awareness formed Group I, whereas students in departments of computer sciences with no such awareness comprised of group II. Male and female candidates between 20 to 35 years who have been using desk top for a period of 3-5 years for a at least four hours daily were included in the research. After informed consent, the convener explained the objectives of all questions regarding awareness and practices of computer usage and facilitated to simplify rationale of few queries.

The instrument comprised of queries on occupational history; information and extent of computer use. They were questioned about understanding of standards available for maintenance of appropriate health at work place, like ideal height of chair, the availability of arm rest, back rest and ideal viewing distance. The computer users with greater length of usage (more than eight hours daily), longer (more than four) consecutive hours or on orthopedics prescription for any musculoskeletal disorder and avid Lap Top users were excluded from the study. The level of awareness and consequent practices were assessed by their response on adjustment of arm rest, inclination of back rest, proper alignment of wrist with elbow and key board and the use of relaxation techniques during short breaks.

Data analysis:

All the responses were fed in SPSS software version 15. Values were presented as mean ± SD; SE of mean, chi square test was applied to evaluate result of test; significant with p value <0.05.

RESULTS

The questionnaire was distributed to 600 individuals of which 375(assigned as Group I) belonged to different professional groups (IT, marketing, business, doctors, engineers and teachers) and 225were students who belonged to computer sciences (assigned Group II). 84incomplete forms (57 from group I and 27 from group II) were rejected from the study. Of the 318from group I who participated in the study 186 were male and 132 female with a mean age of 30 ± 5 years, however, of the 198 students from group II, 129 were male while 69 were female with a mean age of 25± 5years.

When inquired about ergonomic principles, four out of ten from group I had heard about it as compared to six out of ten from group II (p value<0.007). Table1 shows ergonomic awareness and practices in both groups. Group I were good at organizing their workplace (38%) as compared to Group II (23%).The practices of computer Ergonomics within each group are illustrated in Table 3 and Table 4 that show better ergonomic practices by group I participants.

There was a significant difference in the level of awareness of the importance of ideal height of chair between the two groups. Six out of ten participants from group I knew about the health benefits of adjusting the height of the chair with respect to their own size as compared to four out of ten from group II (p=.0011). No evident difference was observed in the practices of the two groups to adjust the chair to a comfortable position (Table 2). Within group I the practice of adjusting the height of the chair was reported by one half of the participants who had this information (p<0.001).

Regarding the information about the depth of seat pan the two groups exhibited significant difference in awareness

level (p=0.0026) with six out of every ten from group I knowing about it versus one out of every four from group II. Seven out of ten from group I reported to adjust the seat for better keying while the same percentage of participants who were aware in group II were also practicing it. Both groups were equally aware of the importance of eye level from the computer screen. Almost all the participants from group I were using this information to maintain the desired distance from computer as compared to half from group II who were practicing it (p=0.0035).

Table 1: Ergonomic awareness and practices in the two groups

	Group I (professionals) (n=318)	Group II (students) (n=198)	P value
Knowledge of height of chair	195(61)	72(37)	0.001
Adjustment of height of chair	102(32)	51(25)	0.355
Knowledge of seat pan	189(59)	72(37)	0.002
Adjustment of seat pan	228(71)	72(37)	0.001
Importance of eye level	159(50)	90(46)	0.521
Keep screen at eye level	141(44)	45(23)	0.003
Awareness of screen filter	168(53)	42(21)	0.001
Keep screen free of glare	57(18)	66(33)	0.022
Importance of closer keying	72(24)	54(27)	0.610
Ergonomic keying	87(27)	24(12)	0.016
Knowledge of arm rest	177(57)	54(27)	0.0002
Always adjust armrest	66(20)	39(20)	0.842
Importance of straight wrist	285(92)	153(34)	0.017
Keep wrist straight	90(28)	48(24)	0.533
Knowledge of elbow position	135(44)	24(13)	0.000
Maintain mouse and keyboard level	123(38)	66(33)	0.450
Awareness of back rest	168(53)	57(29)	0.001
Use a support for lower back	105(33)	45(23)	0.137
Importance of change in posture	201(65)	99(50)	0.073
Change postures at work	225(71)	87(42)	0.000
Knowledge of short breaks	186(60)	108(55)	0.561
Use short breaks	198(62)	90(45)	0.025

Half of the participants from group I and one fifth from group II were aware of importance of screen filters (p<0.0001). The healthy practices to keep computer screens free of glare were different in the two groups. Despite better information a far less percentage of participants i.e. only two out of ten from group I were practicing it (p<0.001). Instead of two out of ten who knew three out of every ten from group II had computer screens free of glare (p=0.02) to comfort their eyes. Equal percentage of participants from group I and II knew about ergonomic keying while this was practiced lesser by group II (p=0.01). The awareness regarding importance of arm rest adjustments was two times

more (six out of ten) in participants belonging to group I as compared to three out of ten in group II (p=0.0002).

There was no significant difference between the practices of the two groups as only two out of ten from each group were adjusting arm rest. Two third of the participants from group I had heard about the importance of ideal height of chair as compared to one third of participants from group II (p=.0011), however, only one third from group I were adjusting it to an appropriate level. There was significant difference between the two groups in the practice of chair adjustment to a relaxed position.

Table2: Comparison of awareness and practices in the two groups

	Group I (professionals)(n=318)		Group II (students) (n=198)	
	Awareness	Practices	Awareness	Practices
Height of chair	195(61)	102(32)	72(36)	51(26)
Seat pan	189(59)	228(72)	72(36)	72(36)
Eye level	159(50)	141(44)	90(45)	45(23)
Anti glare screen	168(53)	57(18)	42(21)	66(33)
Keying	75(24)	87(27)	54(27)	24(12)
Arm rest	177(56)	66(21)	54(27)	39(20)
Position of wrist	285(90)	90(28)	153(77)	48(24)
Elbow position	135(42)	123(39)	24(12)	66(33)
Back rest	168(53)	105(33)	57(29)	45(23)
Postural changes	201(63)	225(71)	99(50)	87(44)
Short breaks	186(58)	198(62)	108(55)	90(45)

Table 3: Comparison of awareness and practices within Group I

Group I (professionals) n=318			
	Awareness	Practices	P-value
Height of chair	195(61)	102(32)	0.000
Seat pan	189(59)	228(72)	0.060
Eye level	159(50)	141(44)	0.409
Screen filter	168(53)	57(18)	0.000
Keying	75(24)	87(27)	0.528
Arm rest	177(56)	66(21)	0.000
Position of wrist	285(90)	90(28)	0.000
Elbow position	135(42)	123(39)	0.58
Back rest	168(53)	105(33)	0.003
Postural changes	201(63)	225(71)	0.243
Short breaks	186(58)	198(62)	0.574

Regarding the information about the depth of seat pan the two groups exhibited significant difference in level of information (p=0.0026) with six out of every ten from group I knowing about it versus one out of every four from group II. Seven out of ten from group I reported to adjust the seat for better keying while the same percentage of participants

who were aware in group II were also practicing it. Both groups were equally aware of the importance of eye level from the computer screen. Almost all the participants from group I were using this information to maintain the desired distance from computer as compared to half from group II who were practicing it (p=0.0035).

Half of the participants from group I and one fifth from group II were aware of importance of screen filters (p<0.0001). The healthy practices to keep computer screens free of glare were different in the two groups. Despite better information, a far less percentage of participants i.e. only two out of ten from group I were practicing it. Instead of two out of ten who knew three out of every ten from group II had computer screens free of glare (p=0.02) to comfort their eyes. Equal percentage of participants from group I and II knew about ergonomic keying while this was practiced lesser by group II (p=0.01). The awareness regarding importance of arm rest adjustments was two times more (six out of ten) in participants belonging to group I as compared to three out of ten in group II (p=0.0002). There was no significant difference between the practices of the two groups as only two out of ten from each group were adjusting arm rest. Within group I, however the practices were noteworthy as only one third of those who knew were making use of it (p=0.842).

Similarly nine out of ten participants from group I knew about the placement of the mouse and keyboard for better wrist position as compared to three out of ten from group II (p=0.0171), however only one fourth participants from each group were keeping their wrist straight. Comparing the awareness and practices within group I the difference was considerable as only one third of all those who knew were maintaining appropriate wrist position (p<0.001).

Four out of ten participants from group I knew about the relation of elbow in line with the wrist while keying, whereas one of ten participants from group II (p<0.001)were aware of this. There was no major difference in practices as four out of ten from group I had their elbow straight in line with the wrist against three out of ten from group II. Within group II there was a remarkable difference between the awareness level and practices of participants (p=0.003) whereby those who were making this adjustment for their own comfort levels were two times more than those who were aware of it. One half of the participants from group I were aware of the use of back rest for continuous work on computers as compared three out of ten from group II (p= 0.001).

There was no sizeable difference in the practices that were carried out for back support by the two groups. Within group I the participants who were using back support dropped significantly from five to three out of ten (p=0.003). There was no significant difference between the two groups in the level of information regarding importance of changing postures while at work. A weighty difference was observed in practices as seven out of ten from group I reported to be changing postures to comfort themselves as compared to four out of ten from group II (p=0.0003). Almost equal percentages of participants from the two groups were aware of the importance of short breaks at work. Short breaks were practiced by the same percentage of participants in group I who knew about it and dropped significantly in group II (p=0.0253).

Table 4: Comparison of awareness and practices within Group II

Group II (students)n=196			
	Awareness	Practices	P value
Height of chair	72(36)	51(26)	0.188
Seat pan	72(36)	72(36)	1.000
Eye level	90(45)	45(23)	0.006*
Screen filter	42(21)	66(33)	0.118
Keying	54(27)	24(12)	0.029
Arm rest	54(27)	39(20)	0.305
Position of wrist	153(77)	48(24)	0.000
Elbow position	24(12)	66(33)	0.004☺
Back rest	57(29)	45(23)	0.426
Postural changes	99(50)	87(44)	0.485
Short breaks	108(55)	90(45)	0.296

*Significant

DISCUSSION

We know that, incorrect accomplishment of specific tasks contribute to discomfort in body posture and subsequently also affect work efficiency [2].Health as well as productivity of individuals can be improved by imparting essential knowledge to apply ergonomic principles that influence the physical and psychological relationship between machines and the end users. These health hazards can be avoided by using ergonomics related knowledge for organization of furniture, placement of computer and adjustment of body posture while at work.

The effect of improper and un safe ergonomics manifests even before students reach graduation, hence educational and ergonomic interventions should commence from undergraduate years or even earlier [5]. Studies also suggest that with growing age the situation awareness level gets reduced in many areas such as field of vision, speed of perception, driving experience etc.[16]. Hence, it is advisable to start ergonomic awareness during early years. So far, educational programs on ergonomics focusing on overall postural health, environmental ergonomics and body mechanics have shown to decrease the frequency of computer related disorders and have enhanced proper use of computers[6,17]. In a similar follow up survey conducted to study the effects of ergonomic training on tele workers, participants were found to have made ergonomic changes in their workplaces and the pain or discomfort that was previously experienced was either reduced or eliminated with ergonomic changes [18].

Knowledge of human machine (computer) interface can be paramount with proper sitting posture, reach of monitor at an arm's length and position of the needed objects with respect to right/left handedness of the individual which help in organization of work place[19,20]Overreaching in any direction causes fatigue, consumes time, reduces productivity, decreases accuracy and increases the risk of injury. In our study a greater number of group I participants were aware of ergonomic principles and a big portion arranged desktop commodities as compared to group II.

With the emerging use of computers numerous studies have been conducted to assess the awareness and practice levels of ergonomics and the prevalence of WMSDs. For one reason or the other, the level of awareness on ergonomics was comparatively less in students comprising of group II in our study as compared to group I assigned to professionals. The results related to students are very similar to a survey conducted in Malaysia where majority of clinical year dental students were experiencing work related muscular disorders. The reason for these problems was poor knowhow of the subject due to minimum participation of these students in previously arranged ergonomic education sessions [21]. Similar studies conducted across the world revealed that the knowledge and practices of dental students was not satisfactory [22, 23].

In our study participants in both the groups reported lesser practice than what they already knew about ergonomics demonstrating a wider gap between information and practices. Many other researches support our findings e.g. the results are consistent with Kamaroddin et al; 2010 [24] who found that though university students who have attended HCI (human computer interaction) courses were well aware of ergonomic principles, only about half of them put them into practice [23]. A similar study on student nurses Swain J, Pufahl E, R Williamson [25]revealed the above mentioned gap when nursing students were not practicing the manual techniques that had been taught to them. A survey on dental students disclosed the prevalence of musculoskeletal problems due to lack of awareness regarding correct posture and improper practices [12].These students (81%) were prone to development of musculoskeletal pain due to lack of awareness regarding correct posture, prolonged static postures, inadequate operating stools and lack of exercises [12].

Aside from students this theory practice gap was cross cutting amongst all computer users in our study emphasizing the need of structured ergonomic sessions focusing on internal motivation to practice what is taught. Hence it becomes important to determine the most effective ergonomic strategy to remove the gap between the knowledge and practice of ergonomics [26].

The knowledge and practices of using ergonomically specific chair is important to avoid WMSDs [20].In our study, participants from group I had more information about the adjustment of height of chair as compared to those in group II and a significant percentage were adjusting it accordingly. A study on ergonomic practices in dentistry also showed that the level of ergonomic awareness with lesser symptoms was highest in 25-34 age groups as compared to higher age groups [27].

Computer ergonomics states to keep shoulders relaxed arms comfortably on sides with arm rests slightly below the elbows, without interfering with access to keying or writing surfaces. Non neutral postures can pull and stretch tendons, blood vessels, and nerves over ligaments or bone thus increasing their chances of becoming strained and restricted. The back of the chair needs to be adjusted upright and tilted for comfort and upper back support, to avoid upper and lower back discomfort. Low backache is the short coming of prolonged sitting in uncomfortable (non-neutral) postures in majority of workers[5]. This can be avoided by comfortable sitting, change in posture, moving chair close enough to keying and relaxation using short breaks. The preventive measures can be taken once the user is aware of importance of adjustment of equipment with respect to his/her stature and work requirement. This was lacking more in group II participants.

Support to forearms and wrists while working on keyboard and input device decreases load on trapezius muscle which acts as a preventive measure to avoid nerve conduction defects leading to MSS[6,16]. Various studies at work places have confirmed an association of improper computer ergonomics with development of aches, pains, carpel tunnel syndrome and MSS[28]. The awareness and skills to apply correct position of arms and wrist is thus important as its decreases the risk of symptoms of the wrist and forearm. Participants from both groups are at an equal risk to the development of these symptoms.

Prolonged work on computers has been associated with diminished power of accommodation, removal of near point of convergence and disturbance in vision [10]. The occupational safety and health administration department of the US Govt. [OSHA] has defined Computer Vision

Syndrome as a "complex of eye and vision problems" that are experienced during computer use; it is a repetitive strain disorder that appears to grow rapidly, with increased visual impairments imposing economic burden [28].The ideal viewing distance of 1.5 feet from computer screen was known to 46% participants in group I, of which 44 % moved seats closer to avoid any visual problem. Half of the participants from group II knew about viewing distance and instead used eye accommodation to focus on the screen instead of chair adjustment. The study thus highlights need for education and reinforcement of all computer users not only to know the ideal viewing distance but to adjust in order to relax ciliary muscles of accommodation [29].

Prolonged sitting has its own health hazards. A study designed to reduce prolonged sitting time introduced a sit stand device and successfully improved upper back and neck pain symptoms in workers in addition to various mood states [30]. In our study a great majority of the participants in each group were well aware of the importance of change in posture at work and were making use of it for health benefits. A higher percentage from group I reported to change posture and take short breaks with indigenous knowledge of the external system. It is documented that, musculoskeletal complaints are also directly proportional to the extensive computer usage [2].

"Prevention is better than cure" is a universal fact and makes us realize the need to know and understand the machines with which we work; this familiarity will enable us to maximize outputs and prevent health related issues as well. The education and implementation of computer related ergonomic principles should therefore start from students who if do not correct their habits from the beginning will continue to carry on; their age might defer onset of MSS but health compromises can defer quality of life, state of wellness and enhance socio-economic burden on the society.

These observations can be useful for ergonomic interventions conducted by the occupational health services to focus on the workplace layout (modifying the physical demands) in combination with a feedback survey of the psychosocial work environment (modifying the psychosocial factors) and individual training focusing on working technique (modifying the individual factors)to increase the efficiency and productivity and a subsequent decrease in musculo-skeletal symptoms.

CONCLUSION

There was a gap in awareness level and practices of ergonomic principles in either group. However those who were aware of these were able to apply safer practices. This suggests the need of an effective strategy to disseminate ergonomic education in order to monitor effective practices.

RECOMMENDATIONS

The study highlights the need to create cultural awareness regarding computer usage ergonomics amongst all users with the importance of self-education and motivation.

LIMITATION

The main limitation of this study was the self reporting of practices without actual observation of these being carried out in the work environment. We relied on the verbal statement of participants that they were aware of ergonomic principles. The diverse background of group I participants was also a limiting factor and no data was presented as regards formal education of the participants.

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