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Comparative Assessment of Upper Limbs Musculoskeletal Disorders by Rapid Upper Limb Assessment Among Computer Users of Zahedan Universities

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Background: Along with widespread use of computers, work-related upper limb musculoskeletal disorders (ULMSDs) have become the most prevalent ergonomic problems in computer users. Thus, study of the ergonomic risk factors related to ULMSDs in computer users has a special importance.
Objectives: The present study was conducted to assess and compare ULMSDs among computer users of Zahedan universities of Technical-Engineering and Medical Sciences by Nordic musculoskeletal questionnaire and rapid upper limb assessment (RULA).
Patients and Methods: This cross-sectional study was conducted on 107 computer users (65 users from Technical-Engineering University; 42 users from Medical University with a mean age of 33.84 ± 7.26 years). A combination of four methods of observation, interviews (to collect demographic data); Nordic musculoskeletal questionnaire (NMQ) (to determine the prevalence of pain signs and symptoms of upper limb musculoskeletal disorders); and RULA (to assess the potential risk of ULMSDs) were used. We used chi-square test for qualitative data analysis, independent-samples t-test for quantitative data analysis between two groups, and 1-way analysis of variance (ANOVA) for multiple comparisons with 0.05 significant levels.
Results: The highest and lowest of pain percentage in computer users belonged to back (77%) and shoulders (51.24%), respectively. The most percentage absenteeism belonged to lower back region (21.5%), and the most percentage over the past 12 months due to low back pain was 19.6%. Pain signs and symptoms in the body parts of shoulder, back, and legs in computer users of Technical-Engineering University were more than those of Medical Sciences University. RULA results showed that 30.8% of the computer users of Technical-Engineering University were located in corrective action level 3 (high risk level) and 42.9% of computer users of Medical Sciences at risk level 2 (moderate risk level). There was a significant relationship between age and RULA final score ($P < 0.05$).
Conclusions: The potential risk and prevalence of ULMSDs among computer users of Medical Sciences University were less than those of Technical-Engineering University due to following ergonomic principles. RULA found to be a proper method for the assessment of the ergonomic risk factors of the ULMSDs in order to prevent such disorders.

*Keywords:*Upper Limbs; Questionnaire; Computer; Risk Factors

1. Background

Along with the use of computers to speed up processes, and save the time, energy and resources, employees' health problems are increasing day by day (1, 2). The main problem in computer related jobs like working with video display terminal (VDT) and video display ultimate (VDU) is cumulative trauma disorders (CTDs) (3). CTDs are a chronic-type of work-related musculoskeletal disorders (WMSDs) caused by exposure to mechanical (ergonomic) risk factors over a long period in the workplace (4). Muscles, bones, ligaments, tendons, tendon sheaths, nerves, and blood vessels are damaged in this type of injury. Some common injuries of this type include tendonitis, tenosynovitis (inflammation of the tendon and its sheath), rotator cuff tendinitis, bicipital tenosynovitis, lateral epicondylitis (tennis elbow), medial epicondylitis (golfers elbow), carpal tunnel syndrome (CTS), cubital tunnel syndrome, thoracic outlet syndrome (TOS), radial tunnel syndrome, pronator teres syndrome, ganglionic cyst, De Quervain syndrome, Guyon's canal syndrome, trigger finger and vibration syndrome (4, 5). Although an acute type of WMSDs such as bunny, hygroma, bursitis and occupational cramp, which develop during a short-term exposure to ergonomic risk factors, has no significant value as occupational health problems (5), upper limbs musculoskeletal disorders (ULMSDs) are significant as the most adverse effect of working with computers and their direct and indirect treatment costs (6). As a result of previous studies, 20%-25% of total costs spent for medical cares, sick leaves, retirements, and pensions in the countries of Northern Europe in 1991 were related to these disorders. It is also estimated that approximately £ 1.25 billion spend on ULMSDs in the UK annually (7). Different studies have shown that approximately 10% of occupational injuries and disorders are associated with the musculoskeletal system (8). Different hypotheses can be accounted for the explanation of the occurrence of musculoskeletal disorders (7, 8). Around the fourth decade of life, muscle strength declines gradually, which is more in women (9). Moreover, along with increased age, the weight of the adipose tissue and subsequently muscles and bones density decrease, and consequently the muscle power is also dwindled (10). Human muscle strength continues to be grown in early adulthood, but in the middle to later ages it declines (9, 10). With increasing age, stretching-mechanical resistance of the bones, muscles, connective tissues, and the joints connectivity are significantly decreased (10, 11). But in most cases, there are factors (beyond the genetic factors and aging), so-called "ergonomic risk factors" due to assigned tasks and jobs, which are involved in inducing the WMSDs (12). The term "work-related musculoskeletal disorders" (WMSDs) implies musculoskeletal disorders that occur by ergonomic risk factors present in assigned tasks and job duties and their influences, which are more than the physiological, anatomical and biomechanical capabilities of the body (13).

Based on the statistics published by the World Health Organization (WHO; 1995), about 58% of the population of older than 10 years in the world spend their time on working (8). This workload leads to $ 21.6 trillion saving in the production and causes the survival of the socioeconomic improvement in the world (8). In a study conducted on 188 women workers in garment industry, it was found that 60% of participants suffered from carpal tunnel syndrome, which is related to their age and job experience (7). Considering the high prevalence of WMSDs and large compensation paid to the injured workers, the prevention and control of these disorders are extremely important, so that the attention of many researchers have been turned to this problem. The best strategy for the prevention and management of WMSDs is using ergonomic risk assessment tools for the evaluation of risk factors causing such disorders in early stage (5, 12). Ergonomic risk factors assessment techniques are semiquantitative or quantitative tools based on the epidemiological, biomechanical, anatomical and physiological studies for the evaluation of workload related to the ergonomic risk factors (task variables) associated with the jobs or tasks that can lead to WMSDs in the long run (4, 5). Ergonomic risk factors assessment tools are divided into four categories; observational methods (Pen-paper based, or computer aided and videotaping observational methods), direct or instrumental methods, self-reporting methods, and psychophysical methods, which each of them has the strengths and weaknesses and different performance for a specific job. In another classification, these methods are generally divided into two categories; whole body techniques and upper limbs techniques (5, 12). Unfortunately, none of these methods is standard, and they only give a prediction and perspective of inducing WMSDs in the near future with respect to the present condition (12). Since the computer users at Medical Sciences University communicate with medical experts, they could obtain much ergonomic information. Therefore, it is predicted that, the general background knowledge, frequency distribution of pain and inappropriate work posture of the users of these two groups differ.

2. Objectives

Because of the high prevalence of complaints regarding the pain signs and symptoms of WMSDs among the computer users of Zahedan Universities, the present study aimed to comparatively evaluate and estimate the prevalence of upper limbs musculoskeletal disorders (ULMSDs) by Nordic musculoskeletal questionnaire and rapid upper limbs assessment (RULA) among computer users of Technical-Engineering and Medical Sciences universities in Zahedan, southeast of Iran.

3. Patients and Methods

3.1. Study Design and Sample Size

This cross-sectional study was conducted on 107 computer users of Zahedan Universities (65 users from Technical-Engineering University and 42 users from Medical Sciences University) that worked for more than 4 hours/day and lack any special diseases affecting ULMSDs. Previous studies regarding the evaluation of musculoskeletal disorders revealed different results regarding the prevalence of ULMSDs. Therefore, considering the lowest percentage of ULMSDs in the neck region (28.1%) and use of the proportions equation (14), the number of required sample size was obtained as follows:

$$n = ((z_{1-\alpha/2})2 \times P \times (1\text{-}P)/d^2 = ((1.96)^2 \times 0.281 \times 0.719)/0.085^2$$

We used , a combination of four methods for data gathering, including direct observation or walking-talking through (to view and analyze the occupational job processes, working conditions and job duties), interviews (to collect the demographic data); nordic musculoskeletal questionnaire (NMQ; to determine the prevalence of pain signs and symptoms of ULMSDs); and rapid upper limb assessment (RULA; to determine the exposure rate of computer users to task variables of inducing ULMSDs, assess the potential risk of such disorders, as well as providing the ergonomic control solutions to improve and modify the work conditions and reduce the prevalence rate of ULMSDs with the aim of eliminating, reducing or minimizing the existing ergonomic risk factors).

3.2. Nordic Musculoskeletal Questionnaire (NMQ)

Nordic musculoskeletal questionnaire (NMQ) as a standardized questionnaire was used to determine the prevalence of ULMSDs signs and pain symptoms in the studied population (15). NMQ was designed and introduced by Kuorinka et al. from Occupational Health Institute of Scandinavian countries and nowadays, it is accepted as a standardized musculoskeletal questionnaire (15, 16). This questionnaire is used for collecting the demographic information such as participants' age, sex, height, weight, job type, and the presence or absence of pain in various body regions (16). To eliminate the effect of the confounding variables, all subjects who had fractures and complications in different body organs due to the accident or suffered musculoskeletal disorders or pains prior to starting this job, were excluded.

3.3. Ergonomic risk Assessment Tool

A pen-paper observational method so-called "rapid upper limb assessment (RULA)" was used for the assessment of the ULMSDs risk factors. This method was introduced by McAtamney and Nigel Corlett for first time in 1993 (17). In this method, the body parts were divided into two groups: group A (upper arm, forearm and wrists) and group B (neck, trunk, and legs) (18). RULA has three stages, including recording working body postures, scoring, and identifying action levels (17, 18). Assessment of the working body posture was done by direct observation of the individual tasks within several job cycles from the right half of the body (17). Score A is obtained from table A by knowing the posture scores for upper arms, forearms, wrists, and wrist twist (18). Score B is obtained from table B by knowing the posture scores for neck, trunk, and legs (19). To calculate muscle activity according to the RULA method guide, depending on the work status as static (for example, the load is held by hand more than a minute) or dynamic (the load is repeatedly held more than 4 times per minute), a score 1 is given and if the work status is neither static nor extremely repetitive, a score zero is considered (19).

Then, a zero score is allocated for the muscle force exerted for work without stress or intermittently holding a load less than 2 kg, a score 1 is considered for a work intermittently holding a load as heavy as 2-10 kg, a score 2 is taken for a static load less than 2 kg and finally, a score 3 belonged to a static load as heavy as 2-10 kg or more. Finally, C score is resulted by adding the scores of muscle activities and forces to the group A score. Score D is also obtained by adding the scores of muscle activities and forces to the group B score. RULA grand score (RULA final score) is gained through table C by integrating and interpolating the scores C and D (17). RULA grand score can be laid on four action levels (17-19):

- Score 1 to 2: shows that posture is acceptable if not repeated for a long time or remain in the same state;
- Score 3 to 4: shows that a more detailed investigation should be done on the present posture in the near future and possible changes may also be required;
- Score 5 to 6: shows that more researches and changes should be done soon;
- Score 7 and more: shows that more researches and changes must be done immediately.

3.4. Data Analysis

After data collection, analyses of NMQ and RULA grand score results were carried out using SPSS V21 through different statistical tests. Some statistical tests used for comparison were as follows: 1-way ANOVA to compare the results of RULA grand scores between different jobs, independent-samples t-test to compare the results of RULA grand scores of two groups, and dichotomous variables paired-samples t-test to compare the results of RULA grand scores between right and left hands, and chi-square test (x^2) to seek the relation between different qualitative variables. Finally, charts and graphs were drawn using Excel package (14).

4. Results

Participants in this study were 107 computer users (including 65 people from Technical-Engineering University and 42 people from Medical Sciences University). Table 1 presents the statistical measures of central and dispersion tendency, including mean, standard deviation, minimum, maximum, and range of age, weight and height of the participants in this study. As it is shown in the table, mean and standard deviation of the age, weight, and height of the computer users are 33.84 ± 7.27 y, 65.75 ± 11.97 kg, and 163.5 ± 8.5 cm, respectively.

Table 1. Statistical Measures of Central and Dispersion Tendency of the Participants

Variables	Statistical Measures			
	Mean ± SD	Max	Min	Range
Age, y	33.84 ± 7.27	55	18	37
Weight, kg	65.75 ± 11.97	100	42	58
Height, cm	163.46 ± 8.53	185	130	55

Table 2 shows the distribution of the pain prevalence in various parts of the body upper limbs. It is seen that there was a significant relation between shoulder pain over the last 12 months and hand posture, so that the most percentage pain (27.3%) in left-handed participants was related to the left shoulder and the highest percentage pain (100%) in right-handed computer users belonged to the their right elbow ($P < 0.05$). The results of the data analysis using chi-square test shows that there were significant relations between the elbow pains in the last 12 months and gender and hand posture ($P < 0.05$). Also the highest percentage pain in men (75%) and in women (66.7%) was related to their right elbow. Based on the results of Table 2, the highest percentage of pain prevalence was related to the low back region (72%), neck (68.2%), hand and wrist (51.4%), and shoulder 65.27%. The results showed that there were significant correlations between the shoulder or knee pain over the past 12 months and university type (Technical-Engineering and Medical Sciences universities). This means that 50% of the computer users of Technical-Engineering University had a pain in the knees, while only 29.8% of computer users of Medical Sciences suffered the pain in this region.

Table 2. Frequency Distribution of Pain Prevalence in Different Body Regions [a]

Body Parts	Pain Signs Prevalence	
	Yes	No
Neck	73 (68.2)	34 (31.8)
Shoulder	61 (65.27)	43 (40.2)
Back	77 (72)	28 (26.2)
Hand and wrists	55 (51.4)	47 (43.9)

[a] Data are presented as No. (%).

The results of the present study revealed that, 12 months before this study, the pain in the knees of the computer users of both Technical-Engineering and Medical Sciences universities was 50% and 25%, respectively. The pain in their shoulders was 60.04% and 39.3%, and the pain in their feet and ankles was 81.3% and 18.8%, respectively. The differences in the pain frequency of the computer users of the two universities was statistically significant ($P < 0.05$), i.e. the pain frequency distribution in the knees, right and left shoulders of the computer users in Technical-Engineering university were more than that of the Medical University users. Moreover, the findings of the study indicated that, although the pain frequency in the back, waist, thighs, and elbows of the computer users of Technical-Engineering University was higher, these differences were not statistically significant ($P > 0.05$). Table 3 demonstrated the frequency distribution of the computer users across RULA grand score and university. As this Table, presents, the highest frequency distribution of computer users in Technical-Engineering University belonged to the risk levels 3 (61.6%), 4 (32.3%), and 2 (6.2%), respectively. The most frequency distribution of participants in the study in Medical Sciences University belonged to the risk levels 3 (57.1%), 2 (23.8%), and 4 (19%), respectively. The highest total frequency distribution of computer users of Zahedan, regardless of their university were related to the risk levels 3 (59.8%), 4 (27.1.8%), and 2 (13.1%), respectively. Also, mean RULA grand score in computer users of Technical-Engineering University and Medical Sciences University were 5.97 ± 0.9 and 5.36 ± 1, respectively. Mean RULA grand score of computer users of Zahedan Universities was found 5.7 ± 1. Chi-square revealed a significant difference between RULA action levels of Technical-Engineering and Medical Sciences Universities ($P < 0.05$). Therefore, most of the computer users of Technical-Engineering University (38.5%) had risk levels of 3 or higher. While, most of the computer users of Medical Sciences University had risk levels of 2 or lower. More than 32.3% of the computer users of Technical-Engineering University and 19% of the computer users of Medical Sciences University were posed at risk levels higher than 4 (RULA score more than 7) i.e. extremely high risk for ULMSDs.

Table 3. Frequency Distribution of Computer Users across RULA Risk Levels and University Type [a]

University Type	RULA Risk Levels			Total
	Risk Level 1 (RULA Score 3 or 4)	Risk Level 2 (RULA Score 5-6	Risk Level 3 (RULA Score 7)	
Technical-Engineering	4 (6.2)	40 (61.6)	21 (32.3)	65 (60.75)
Medical Sciences	10 (23.8)	24 (57.1)	8 (19)	42 (39.25)
Total	14 (13.1)	64 (59.8)	29 (27.1)	107 (100)

[a] Data are presented as No. (%).

Table 4. Frequency Distribution of Neck Pain Prevalence and RULA Risk levels [a]

RULA Risk Level (RULA Score)	Neck Pain Prevalence		
	Yes	Total	
2 (3-4)	7 (6.54)	7 (6.54)	14 (13.08)
3 (5-6)	39 (36.44)	25 (23.36)	64 (59.8)
4 (7)	16 (14.95)	13 (12.17)	29 (27.12)
Total	62 (57.93)	45 (42.07)	107 (100)

[a] Data are presented as No. (%).

Table 5. Frequency Distribution of Low Back Pain Prevalence and RULA Risk Levels [a]

RULA Risk Level (RULA Score)	Low Back Pain Prevalence		
	Yes	No	Total
2 (3-4)	5 (4.67)	8 (7.48)	13 (12.15)
3 (5-6)	30 (28.04)	36 (33.64)	66 (61.68)
4 (7)	7 (6.54)	21 (19.63)	28 (26.17)
Total	42 (39.25)	65 (60.75)	107 (100)

[a] Data are presented as No. (%).

Table 4 shows the frequency distribution of the computer users across neck pain prevalence and RULA risk levels. There was a significant relation between neck pain prevalence and RULA risk levels ($P < 0.05$). The highest prevalence of neck pain belonged to RULA risk levels 3 (36.44%), 4 (14.95%), and 2 (6.54%).

Table 5 shows the frequency distribution of the computer users across low back pain prevalence and RULA risk levels. There was a significant relationship between low back pain prevalence and RULA risk levels ($P < 0.05$). The highest prevalence of low back pain belonged to RULA risk levels 3 (28.04%), 4 (6.54%), and 2 (4.67%).

Table 6 shows the frequency distribution of the computer users across knees pain prevalence and RULA risk levels. There was a significant relationship between knees pain prevalence and RULA risk levels ($P < 0.05$). The highest value of knees pain prevalence were related to RULA risk levels 3 (37.38%), 4 (13.08%), and 2 (2.8%).

Table 6. Frequency Distribution of Knees Pain Prevalence and RULA Risk Levels [a]

RULA Risk Level (RULA Score)	Knees Pain Prevalence		
	Yes	No	Total
2 (3-4)	3 (2.8)	11 (10.28)	14 (13.17)
3 (5-6)	40 (37.38)	24 (22.43)	64 (59.8)
4 (7)	14 (13.08)	15 (14.02)	29 (27.03)
Total	57 (53.27)	50 (46.73)	107 (100)

[a] Data are presented as No. (%).

5. Discussion

The study showed that the prevalence of ULMSDs among computer users of Zahedan universities is pretty high, which may be due to older age of the participants. The mean age of the computer users in this study was 33.84 years (ranged 55-18 years) that can be attributed to the high prevalence of ULMSDs (neck, back, and knee) in this population. The highest prevalence of pain belonged to lower back (72%) and after that, neck (68.2%), wrist and hand (51.4%), and shoulder (27%). The reason for high prevalence of musculoskeletal pain and symptoms can be related to the repeated activity in this region, the role of this part in high force exertion, long-term involvement of this part in static works, high muscle activity, hypermobility of low back, inadequate rest breaks (recovery periods) between work periods, individuals' genetic susceptibility to ULMSDs, poor nutrition, poor design of tools and equipment working with the computer, awkward postures during work with computers, high frequency and repetition of tasks in short times (minutes), and other factors (sharp-edged objects, precision work, exposure to cold, heat, exposure to vibration and psychological problems, etc.) (1-3, 18). More than 32.3% of computer users of that Technological-Engineering University and 19% of the computer users of Medical Sciences University had a high risk level (risk level 4 or RULA score 7) for musculoskeletal disorders. According to the international office work standards, workstations with high risk of musculoskeletal disorders (RULA risk level 4 or RULA score 7) must be immediately modified to lower risk levels by changing the improper ergonomic risk factors involved in job process (by taking engineering or administrative solutions). These results are consistent with the results of the risk assessment of upper limbs musculoskeletal disorders (ULMDs) in computer users in Malaysia by Sen and Richardson (1) in which, about 50% of those with some low back pain lacked an adjustable backrest. Many users had higher RULA scores of the wrist and neck suggesting increased risk of developing Occupational Overuse Syndrome (OOS), which needed further intervention. Also, many users (64%) were using refractive corrections and still had high scores of Computer Vision Syndrome (CVS), including eye fatigue, headache, and burning sensation. Furthermore, they observed that increase in CVS scores (suggesting more subjective symptoms) correlated with increase in computer usage spells (1). Similarly, in a study conducted by Moussavi-Najarkola and Mirzaei aimed at the assessment of ULMDs loads due to posture, movement, force, and repetition by using RULA method on 566 male and female in textile factory workers, it was quantified that musculoskeletal disorders prevalence in upper arms, forearms, wrists, trunk, and legs were 87.8%, 45.1%, 56.2%, 67.7%, and 28.8%, respectively. Also, RULA assessment revealed that tasks of spinning, direct wrapping, and guard machines were hazardous tasks with scores higher than 7 (19). The results also showed that 68.2 % of participants had neck pain, which is consistent with the results obtained from other studies on ULMSDs (1-3, 19). However, opposite results were obtained in a study conducted by Hochnanadel on computer workstation adjustment (20). This difference may be related to the small sample size and studied work type led to neck repetitive movements. This study revealed that 72% of participants had low back pain, which is similar to the findings obtained from the study carried out by Sen and Richardson (1). They studied ergonomic risk factors affecting occupants' body posture and aimed to assess ULMDs in computer users in Malaysia that quantified many of the users had low back pain due to their awkward postures within their duties. Likewise, Hochnanadel study on computer workstation adjustment confirmed that most of the computer users had ULMSDs (low back disorder) that can be attributed to the forward bending during different tasks and improper use of chair within various works (20).

In this study, 27% of computer users had shoulder disorders that was almost similar to the results found by Moussavi-Najarkola and Mirzaei on textile factory workers in Qaemshahre that showed the lowest shoulder problem in their assigned work was due to low frequently repetitive movements in this body region (19). Unlike this study, Hochnanadel reported high prevalence of shoulder disorders on computer users in different workstations that can be referred to the static posture of this body part (20). Similar results were gained in Sen and Richardson regarding the survey of the role of the ergonomic risk factors in computer users' postures in Malaysia. They found that most of the computer users showed low shoulder pain in their tasks due to frequently dynamic postures (1). The results showed that 51% of participants had wrist disorder, which was consistent with the findings of Moussavi-Najarkola and Mirzaei study. Their study revealed that around 318 workers (56.2%) of textile factory showed wrists disorders that can be due to grasping movement, frequent motion, and highly dynamic gripping of this body part during different tasks (19). Similar results were found in Sen and Richardson study on the role of the ergonomic risk factors on ULMSDs in Malaysian computer users that showed most computer users had moderate prevalence of wrist pain in computer tasks due to extremely repetitive movements of this body part (1). Unlike this study, Hochnanadel attributed the low prevalence of wrist disorders on computer users in different duties to the use of wrist-rest in their working jobs that led to moderate repetition and almost good posture of the wrist (20).

Generally, the RULA risk assessment suggestion can be used for prevention ULMSDs in computer users (1, 19-22). The results showed that elbow, low back, and knees pain over the past 12 months were more in women than men. It is clear that the highest percentage pain in men (75%) belonged to their elbows, while the highest percentage pain in women (66.7%) was associated with their both elbows. Forty percent of men lacked low back pain, but 80% of women suffered from serious low back pain. Half of men reported no knee pain, but 80.7% of women experienced some pain in their knees. Increased elbows and knees pain can be attributed to mismatching and non-fitting of the user's chair with their body (20, 21). RULA risk assessment suggested that the following instructions for prevention of ULMSDs in computer users (1, 19-21):

- Hands, wrists, and forearms should be straight, in line and parallel to ground (1, 22).
- Head should be straight, or bent slightly forward, and generally be in line with the torso (21).
- While relying, upper and lower back should be entirely kept constant by back rest or support.
- Elbows should be kept close to the body with the angle between 90 and 120 degrees (20).
- Feet soles should be fully posed on the ground (1).
- Thighs should be located on a soft seat and parallel to the ground (18).
- Knees should be posed approximately hips height and the legs should be slightly ahead (1).
- Use paper holders on the right hand to minimize the pressure on the neck and back and reduce muscular and visual fatigue (20).
- Work desks nearby the window should be placed as the computer to be normal to the window and computer display to be located at right angle. Also avoid the glare due to locating the computer desk in exposure to direct light (2).
- Seat height should be adjusted, so that the person can adjust it to suit in proportion to his or her height, in such a way that feet soles rest on the ground and knees to be at right angle (20, 21).
- If possible, adjust the seat handle height. Consider that these handles are only for resting time, not for typing (1).
- Note that the chair wheels move easily and nothing obstruct them. In case your chair is not adjustable, use a cushion on the chair to raise your seat height, when your chair height is low. If your chair height is high, use a footrest. You can use a large book or a blank box instead of the footrest. Also, use a back-pad if you are far away from your computer sets (1, 19).
- Use a footrest if necessary. Kept your back straight as much as possible during working and footrest angle should be 15 degrees (20).
- Distance of monitor to eye should be proper, so that monitor should be located exactly in front of the user's eye with 40-60 cm distance (the size of an open hand). Characters and images on the monitor must be clear and legible, and use dark characters on the light background. Avoid bending on the keyboard (18).
- Try to bring up the screen as much as possible, so that the hands be perpendicular to the upper arms. Therefore, you do not have to bend down for a long period (20, 21).
- Provide the computer room temperature at 19-23°C and humidity of 50% and good ventilation for enhancing the efficiency and performance. Taking rest and stretching practice before computer working is the best way to prevent ULMSDs (19).
- Fitting the computer working jobs to the appropriate users is a scientific principle and ergonomic solution. These people should be undertaken the pre-employment, periodic and specific examination tests for early detection of any ULMSDs problems in order to prevent them (21).

Some examinations such as optometry and different musculoskeletal diagnosis tests, including standard clinical provocation tests (Finkelstein’s test, Phalen’s test and Tinel’s test), joint stress test, Allen test, Mills test, Impingement-test, Speed’s test, Yergason test, biceps resistance test, Roos test, Adsons test, elevated arm stress test, foraminal test, and the like can help to reach this preventive purpose (4, 21, 22).

The potential risk and prevalence of ULMSDs among computer users of Medical Sciences University were less than those of Technical-Engineering University due to the mentioned ergonomic principles. RULA was found to be a proper method for the assessment of the ergonomic risk factors of the ULMSDs and accordingly prevent them.

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Authors' Contributions

All authors were equally contributed in preparing this research.

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