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Evaluation of psychometric properties of the maastricht upper extremity questionnaire (MUEQ) in iranian computer users

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Abstract:

BACKGROUND: Measurement of the essential risk factors for work-related musculoskeletal disorders is a fundamental step in predicting the problem and identifying high-risk individuals. In this regard, Maastricht upper extremity questionnaire (MUEQ) has not been validated in Iran. This study aimed to develop a valid and reliable Persian version of MUEQ.

MATERIALS AND METHODS: In this descriptive study, the computer users employed in a governmental informatics administration in Tehran, Iran, were included during the end of 2018 and early 2019. Face and content validity of the MUEQ was conducted, and a six-part questionnaire was provided. The reliability of the questionnaire was obtained using Cronbach's α and test–retest. Concurrent validity was assessed with Nordic Musculoskeletal Questionnaire (NMQ). Exploratory and confirmatory factor analysis, comparison test of independent mean, internal consistency coefficient, test–retest, and Pearson correlation were carried out using the AMOS and SPSS 22 software.

RESULTS: Participants consisted of 282 computer users (110 males) with a mean age of 35.17 ± 7.65 years. The mean duration of computer use in a working day was 6.68 ± 2.10 h with a range of 1–12 h. The most prevalent symptoms were existed in the neck (39.1%), back (31.0%), and lower back (30.3%) areas. KMO test and Bartlett's test of sphericity showed that a significant correlation existed among questions. Cronbach's alpha coefficient of the questionnaire varied from 0.61 to 0.83 and test–retest coefficient was higher than 0.7. Correlation coefficient was between NMQ and body posture ($r = 0.23$, $P = 0.004$) and between NMQ and work environment ($r = 0.28$, $P = 0.000$). Evaluations related to the construct validity and concurrent validity demonstrated that the questionnaire has acceptable construct validity. Six factors of the MUEQ in Root Mean Squared Error Approximation (RMSEA) index (0.062) were acceptable and satisfactory in Parsimony Comparative Fit Index (PCFI), Comparative Fit Index (CFI), Normed Fit Index (NFI), and Parsimony Goodness of Fit Index (PGFI) (0.732, 0.8000, 0.680, and 0.680, respectively).

CONCLUSIONS: The Persian version of the MUEQ represented a satisfactory validity and reliability and was suitable for computer users in the assessment of their risk factors of musculoskeletal complaints.

Keywords:

Maastricht upper extremity questionnaire, Musculoskeletal disorders, Psychometrics

Introduction

Over the past 20 years, the development of information technology (IT) and communication has led to a significant increase in the number of computer users.[1] Studies have shown that work-related musculoskeletal disorders (MSDs) are considered a major health concern[2] and they

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clearly present in several employees, including computer users.[3-5] There is a causality relationship between computer work and MSDs in the arm, neck, and shoulder.[6] Continuous work with a computer in sitting and static position can be considered as one of the main risk factors of MSDs in the workplace. According to recent studies, the annual prevalence of hand, arm, shoulder, and neck symptoms varies from 10% to 42% in computer users.[7]

Accordingly, assessing MSDs and evaluating risk factors in computer users are very important. In Iran, Nordic musculoskeletal questionnaire (NMQ) has been used for many years to determine the prevalence of MSDs, which was designed and provided at the Institute of Occupational Health in the Scandinavian Peninsula in 1987.[8] In this questionnaire, only MSDs are evaluated and the risk factors are not investigated. Recent studies, however, have indicated that the origin of MSDs can be varied, including individual, psychosocial, and organizational issues.[9]

Recognizing as well as measuring these risk factors in MSDs is an important step in identifying high-risk groups and effective interventional actions. To this end, the Maastricht upper extremity questionnaire (MUEQ) was first published in 2007 and its validity has been evaluated in several countries.[10-12] This questionnaire is a screening tool that expresses the nature, prevalence, and potential physical and psychological occupational risk factors of MSDs in computer users. The MUEQ contains eight sections, including demographic information and seven main parts (work environment, postural condition, job control, job demand, break time, work environment, and social support). The prevalence of complaints in the upper areas is also evaluated by this questionnaire. This questionnaire detects the prevalence of MSDs over the past year, as well as physical, psychology, and environmental risk factors in work environment.[13]

To date, the questionnaire has not been translated into Persian in Iran. Therefore, the purpose of this study is to assess the construct validity and reliability of this tool for the first time in the country. In fact, three basic questions will be answered in this study.

1. What is the face validity and reliability of the questionnaire in computer users?
2. What is the internal consistency of the questionnaire in computer users?
3. What is the face, construct, and criterion validity of the questionnaire in computer users?

Materials and Methods

Study population

In this descriptive study, the participants were comprised of a governmental corporation staff in Tehran, Iran. The employees worked as computer users (designer, planner, financial officer, typist, manager, etc.,) in an integrated workstation partitioned off by partition walls to single workrooms. The study population consisted of professional computer users who spent several hours on computer activities. To assess the psychometric properties of the MUEQ, 282 computer users were selected by convenience sampling method. From a quantitative point of view, in order to conducting a correct Fact Analysis the sample size is considered as at least two individuals for each question. Since there were about 100 items in the questionnaire, we should select at least 200 participants which is the minimum required sample size.[14].

Eligibility criteria

The inclusion criteria were considered job activity as a computer user for at least 6 months and working with computers at work for at least 3 h a day. The exclusion was on the basis of the following criteria: age under 18 and over 50 years, history of surgery in the shoulder and upper limb area, presence of disability, diagnosed psychiatric disease, history of rheumatologic or joint degenerative disease, and not signing informed consent for participation in the study.

Maastricht upper extremity questionnaire

The MUEQ was first developed in 1999. The psychometric properties of this questionnaire have been evaluated in several studies.[15,16] The MUEQ is actually a completed version of the disability questionnaire. The questionnaire consists of 95 questions and one can complete it in about 20 min.[17]

Other than demographic questions, the questionnaire has seven main sections: (l) workstation; (2) body posture; (3) job control; (4) job demands; (5) quality of rest breaks, (6) work environment, and (7) social support. A complementary part of the questionnaire has been designed to determine the frequency and the nature of pain in the neck and upper extremity.

Since the questions of the work station have two-choice answers (yes/no), they could not be entered into the factor analysis. Hence, final analysis was conducted on six sections.

The output of the MUEQ included the rate of upper limb problems' occurrence and the possible ergonomic and psychosocial risk factors in computer users. The mentioned seven sections are relevant to predisposing factors as follows:

1. Definition of the workstation: In this section, ergonomic indices such as computer desk, work surface height, type of chair, and its characteristics and the location of the keyboard, screen, mouse, and other components are under question

2. Body posture during work: In this section, body posture is evaluated while working with a computer. Thus, the static position, neck flexion, head or trunk rotation, trunk bending, hand activities beyond the shoulder height, and wrist and hand position while working with the computer are questioned in detail
3. Job control: In this section, the relationship between the individuals and management system, the problem-solving ability, job creativity, the ability to select responsibilities, and the initiative in performing job tasks are examined
4. Job demands: In this section, the volume of required and expected work of the person is measured by assessing the duration of performing the task, the speed of working, variety of the tasks, the workload, the number of job duties, and the responsibility of individuals in relation to the tasks assigned
5. The quality of rest breaks: In this section, the number of break times at work intervals, the approximate number of breaks, and the authority of determining the time/number of rest breaks are examined
6. Working environment: In this section, the physical conditions of the work environment are detected in terms of light, temperature, ventilation, surface light reflexes, etc.
7. Social support in the workplace: In this section, the level of support and cooperation of colleagues, supervisors, and managers and the degree of confidence between colleagues are evaluated.

The other two parts of this questionnaire consist of (1) individual and demographic information and (2) a table in which the individuals report his/her medical problems in different anatomical parts of the left and right upper extremities over the past 12 months. The medical problems noted in this section include pain, joint movement limitation, paresthesia, and feeling of stiffness and swelling. In addition, diagnostic and therapeutic follow-up for medical problems was also evaluated.[16] The MUEQ contains about 100 questions (95–107) that individuals must complete in 20 min.[16]

The field activity of the study was started in June 2018 and ended in February 2019. The method stages of the study are listed as follows:

1. Preparation of the original questionnaire of MUEQ (English version)
2. Forward and backward translation of the questionnaire with standard multistage method by three independent persons (two occupational medicine specialists and one expert in health education) who were familiar with native English writing
3. Investigation of face validity by holding a meeting with the presence of specialists in occupational medicine, health education, orthopedics, and psychiatrics to finalize the tool
4. Content analysis and review of the questionnaire to detect misunderstanding phrases/words conducted by 50 computer users
5. Assessing the reliability through the internal consistency coefficient and the test–retest by conducting a pilot study on 50 participants
6. At the end of this stage, a questionnaire with 85 items was prepared in which each section included 7–27 questions [Table 1].

It should be noted that seven questions of work environment atmosphere were removed because of nonspectrum responses from the factor analysis process.

Implementation of the main study

At this stage, seven-page printed questionnaires were punched and provided for participants by a health education expert. There were also explanations on how to respond to the options and the content of the questions for the audience. Other than the MUEQ, the NMQ was delivered to the audience. It was considered as a comparison index with the main questionnaire of the study. The participants in the study were asked to complete the entire questionnaire within a day.

Ethical considerations

All information was secretly guarded by supervisors and refused to be provided individually. Individuals were free to end participation for any personal reason. The Ethics Committee of the Baqiyatallah University of Medical Sciences approved the project with the ethics code of IR.BMSU.REC.1394.243.

Data analysis method

To respond to the research questions, inferential statistics (exploratory factor analysis [EFA]), comparison test of independent mean, internal consistency coefficient, test–retest coefficient, and Pearson correlation test were carried out using SPSS version 22.0 (SPSS Inc Chicago, IL, USA). (SPSS Inc Chicago, IL) To investigate the factor structure, the EFA method was used by principal component and varimax rotation method. The maximum method and the IBM *SPSS Amos* (IBM SPSS Amos v18,Chicago, U.S.A.) were used to analyze the confirmatory factor analysis (CFA). The modification indices beyond 15–20 were applied to fit the model.

Results

Of the total 282 computer users, 110 were (39%) female. The minimum and maximum ages of the respondents were 22 and 56 years for men and were 21 and 54 years for women, with a total mean age of 35.17 ± 7.65 and a range of 21–56 years, respectively. The range of duration of computer use was 1–12 h with the mean and standard

Table 1: Scales and sample questions of Maastricht upper extremity questionnaire

Scales	Number of questions	Sample question
Work environment atmosphere	7	My desk (table) at work has suitable height (70 cm)
The user's physical posture	10	During my work, I keep a good work posture
Job control	9	I decide how to perform my job task
Job demands	7	I work under extensive work pressure
Rest breaks	8	I can plan my work breaks
Work environment	9	I find my work environment good
Social support	8	My work atmosphere is comfortable
Pain and other medical problems	27	During the past year, I had pain/complaint/disability in my upper extremities Yes/no

deviation of 6.48 ± 2.10 h. Other demographic factors are presented in Table 2.

The results of factor analysis showed that the MUEQ consists of six factors that explain 46.8% of the total variance. The first factor explains the body posture with 9.88% of the total variance, of which eight questions on this factor have a factor load of more than 0.30. The second factor (job control) explains 8.289% of the total variance, and six questions on it have a factor of more than 0.30. The third factor (job demand) explains 7.983% of the total variance, and seven questions on this factor have a factor load of more than 0.30. The fourth factor (break time) explains 7.533% of the total variance, and eight questions have a factor load of over 0.30 on that factor. The fifth factor (work environment) explains 7.362% of the total variance, and seven questions on the factor have a factor load of more than 0.30. The sixth factor (social support) explains for 5.094% of the total variance, and eight questions have a factor of more than 0.30 on that factor. Furthermore, in comparison with the original musculoskeletal questionnaire, seven questions (number 9, 13, 20, 21, 22, 46, and 47) were not loaded on any of the factors due to their low correlation with the factors and were excluded from the analysis process of CFA.

Bartlett's test was used to assess the significant correlation of questions. Table 3 shows sampling adequacy (KMO) and Bartlett's test of sphericity.

The index (KMO) varies from zero to one (ranging from 0.9 to 1 means excellent, 0.8 to 0.9 is considered as good, 0.7 to 0.8 and 0.6 to 0.7 means satisfactory and average, respectively. If it is between 0.5 and 0.6, the sample size is inadequate and less than 0.5 is not acceptable). Therefore, the results of Table 3 show that sampling adequacy (KMO >0.901) is at a satisfactory level, as well as Bartlett's test of sphericity ($P < 0.001$). In other words, the sampling adequacy index is equal to 0.763, and the results of Bartlett's test showed a sufficient significant correlation. The Scree plot in Figure 1 shows that in MUEQ, there are six factors with a special value greater than 1.5.

Table 2: Demographic characteristics of participants

Demographic variable (*n*=282)	Values
Sex (%)	
Male	110 (39)
Female	172 (61)
Age	35.17±7.65
Length of computer using	6.48±2.10
Employment time (year)	6.98 (5.91)
Working days per week	7 (8.55)

Table 3: Sampling adequacy and Bartlett's test of sphericity

Indicators	Values
Sampling adequacy index	0.763
Bartlett test	5404.968
Degree of freedom	1275
significance	0.001

Table 4: Goodness-of-fit indexes of the 6-factor of the Maastricht upper extremity questionnaire (*n*=282)

PCFI	PGFI	NFI	CFI	RMSEA	$\frac{\chi^2}{df}$	*P*	df	χ^2
0.732	0.680	0.680	0.800	0.062	2.082	0.001	866	1802.885

CFI=Comparative fit index, NFI=Normed fit index, CI=Confidence interval; PGFI=Parsimony goodness of fit index, PCFI=Parsimony comparative fit index, RMSEA=Root mean squared error approximation

Figure 2 shows the CFA model and Table 4 shows six factors of the MUEQ which in RMSEA index (0.062) was good and satisfactory in PCFI, CFI, NFI, and PGFI (0.732, 0.8000, 0.680, and 0.680, respectively).

To obtain the concurrent validity, the correlation between the MSDs and its subscales was calculated with complaints and pain caused by working with the computer in NMQ.

Table 5 shows the correlation matrix of the subscales of the MUEQ. Pearson's correlation test was used to evaluate correlation. The correlation coefficient of all subscales of MUEQ with a checklist of complaints and pain caused by working with a computer is significant at the level of $P < 0.01$ and $P < 0.01$.

Furthermore, Table 5 indicates a positive and direct relationship between the checklist of complaints and pain caused by computer work with the subscales of body posture, job demand, and work environment as well as a negative and inverse relationship with the subscales of job control, break time, and social support. In other words, by increasing problems in the areas of the body posture, job demand, and the work environment, the complaints and pain caused by computer operating increases, and by increasing work control, the time of rest, and social support, these consequences decrease.

To evaluate the validity of the MUEQ, internal consistency coefficient and test–retest coefficient were used. Table 6 shows that the range of internal consistency coefficients (Cronbach's α) of questionnaire subscales varies from 0.61 to 0.83, so that the lowest α coefficient belongs to the subscale of the body posture and the highest α coefficient belongs to the subscale of social support. Meanwhile, the internal consistency coefficient (Cronbach's α) of the entire questionnaire was 0.62. In addition, the test–retest coefficients of the MUEQ were at a favorable level (higher than 0.7).

Among the 261 respondents in this section, the highest prevalence of complaints was reported in the neck area and the lowest in the ankle. Table 7 shows the prevalence of musculoskeletal complaints and pain caused by computer operating in study participants, which was shown by frequency and percentage.

Correlation coefficient between NMQ and body posture (r = 0.23, P = 0.004) and between NMQ and work environment (r = 0.28, P = 0.000) indicated a weak correlation and a direct correlation between the two tools.

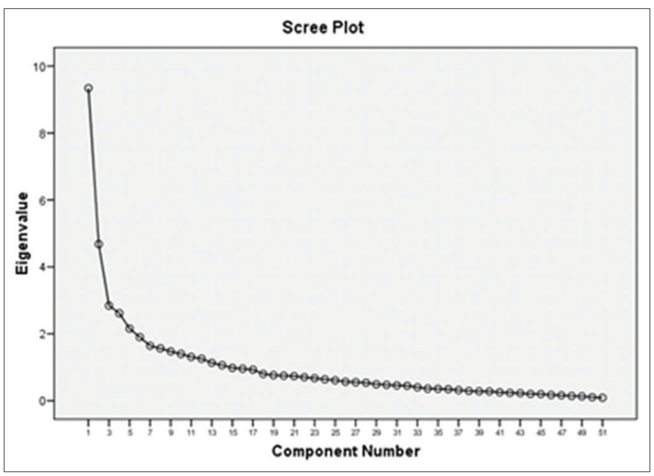

Figure 1: Eigen value distribution of the Scree plot

Discussion

Main findings

This study presents a valid and reliable MUEQ, which was analyzed as a Persian cross-cultural–adopted version. Correlation significance among questions, internal consistency, and test–retest coefficient of the questionnaire was at a desirable level. Evaluations

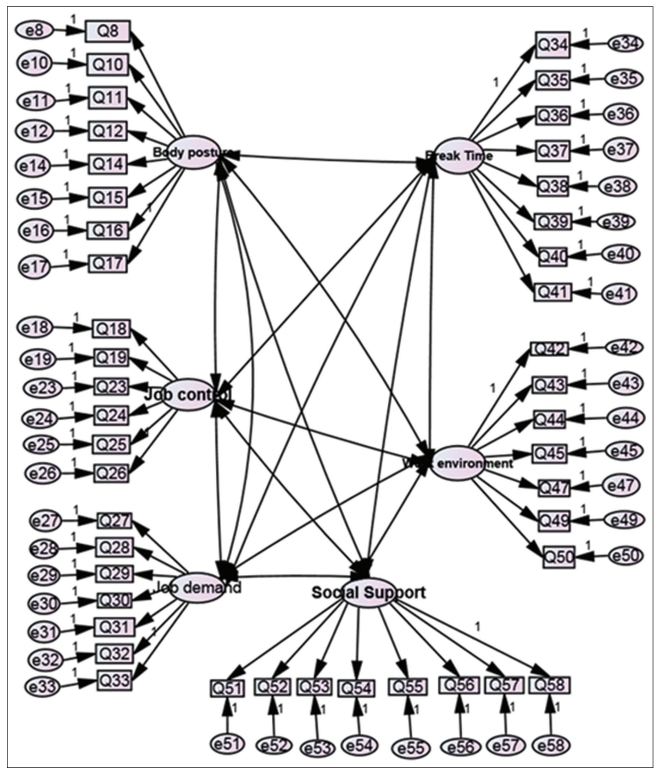

Figure 2: Confirmatory factor analysis of six items of Maastricht upper extremity questionnaire (n = 282)

Table 5: Correlation matrix of subscales of the Maastricht upper extremity questionnaire with complaints and pain caused by working with computer checklist (*n*=282)

Variables	Complaint and pain	Body posture	Job control	Job demand	Rest breaks	Work environment	Social support
Complaint and pain	1						
Body posture	0.219*	1					
Job control	−0.116*	−0.093	1				
Job demand	0.134**	0.272**	0.053	1			
Rest breaks	−0.123**	−0.220**	0.416**	−0.278**	1		
Work environment	0.255*	0.246**	−0.269**	0.166**	−0.036	1	
Social support	0.187*	−0.109	0.499**	−0.204**	0.291**	0.292**	1

*Significant at level 0.01, **Significant at level 0.05

related to the construct validity and concurrent validity represented that our Persian version of MUEQ has acceptable construct validity.

In terms of the factor structure of the MUEQ, we considered six subscales, including body posture, job control, job demands, rest breaks, work environment, and social support. The subscale of body posture formed the most factor load and the subscale with the lowest factor load was social support. This indicates that body posture was the most important factor among the participants. Eight questions were loaded into this factor.

The next factor was the subscale of job control. The authority to do one task is one of the most important areas of job control. This is called in some cases decision-making power.

The demand-control model is a prominent source of job stress. High-demand and low-control jobs create a higher risk for health. Studies have shown that computer systems with high performance are in parallel with low-control levels.[18]

The third fact was job demand. In a cohort study in the UK among middle-aged individuals, lower job demand had an association with better mental performance and higher job control as well as physical/mental health in the remaining years of life and retirement time. However, this relationship may be due to the unhealthy behaviors of these individuals and their weaker socioeconomic conditions.[19] This finding by itself is related to the level of occupational stress of the individual, which may be due to no compatible job demands.[20]

Table 6: Validity and test-retest coefficients of Maastricht upper extremity questionnaire (*n*=50)

Subscales	Questions number	Internal consistency coefficients	Test-retest coefficients (Cronbach's α)
Body posture	8	0.61	0.826
Job control	6	0.77	0.977
Job demands	7	0.81	0.975
Rest breaks	8	0.82	0.789
Work environment	7	0.67	0.963
Social support	8	0.83	0.986
The entire of questionnaire	44	0.62	0.897

The next factor is the rest breaks of the work environment, which is placed in the next step of priority in comparison with body posture, job control, and job demand from the community perspective. From our participants' point of view, rest break was less important than the rest of the questionnaire's variables. Maybe, it is because computer users pay less attention to their break time while working with the computer. However, break time is especially important for computer users.

The fifth and sixth factors were the work environment subscale and social support subscale, respectively. Work environment factors such as cold, heat, and air conditioning have a tremendous effect on the individual's comfort. The characteristics of social networks, such as families, friends, colleagues, neighbors, and others, and also social transactions, impress good effects on tangible assistance. Further, perceived support aims to help people deal with daily life, especially in response to critical situations. Social support depends on socioeconomic factors which are higher in young people, married people, those with a higher job, and those with socioeconomic status.[21] Our participants were at a moderate socioeconomic level and mostly middle aged.

The structure of the six factors of the questionnaire in the present community was acceptable and the goodness-of-fit indicators were appropriate. Of course, the goodness-of-fit indicators did not fit well, most likely due to the large amount of questions, the type of community under study, and the demographic factors which have affected this fitness.

Reliability

Concerning internal cohesion of the instrument, the subscales with lowest and higher Cronbach's α coefficient were belonged to the subscale of the body posture and social support, respectively, all of which

Table 7: Prevalence of musculoskeletal complaints and pain in study participants (*n*=261)

Physician advice in the past 12 months	Complaints and pain in the past 8 months, *n* (%)	Complaints and pain in the past 12 months, *n* (%)	Complaints and pain area, *n* (%)
Neck	102 (39.1)	101 (38.7)	26 (10)
Shoulder	42 (16.1)	34 (13.0)	10 (3.8)
Elbow	31 (11.9)	27 (10.3)	11 (4.2)
Wrist	58 (22.2)	43 (16.5)	17 (6.5)
Upper back	81 (31.0)	70 (26.8)	30 (11.5)
Lower back	79 (30.3)	74 (28.4)	31 (11.9)
Hip	56 (21.5)	50 (19.2)	17 (6.5)
Knee	83 (31.8)	77 (29.5)	25 (9.6)
Ankle	30 (11.5)	23 (8.8)	5 (1.9)

were at the desirable level. The Cronbach's α between 0.7 and 0.9 is considered as sufficient reliability of the questionnaire.[22]

In other words, according to several studies, if the target analysis shows a valid coefficient between 0.70 and 0.80, it deems sufficient. In this study, the obtained α rate was higher than 0.6 and less than 0.9, which indicates the sufficient internal validity of the questionnaire. The internal consistency coefficient (Cronbach's α) of the entire questionnaire was 0.62. The Rapid Office Strain Assessment Tool has also acceptable reliability. In a study in Brazil, Cronbach's α tool was higher than 0.7 and the item-total correlation was between 0.28 and 0.75.[23]

A 41-item questionnaire was tested on the population of Brazilian computer users, and it had an alpha greater than 0.7 and an intra-class correlation coefficient greater than 0.75. Further, the item-total correlation was between 0.28 and 0.75.[23]

The Greek version of the Cronbach's alpha was between 0.52 and 0.89.[24] The Arabic version of the mentioned alpha was higher than 0.7 and in total was between 0.48 and 0.94. The computer position, task complexity, autonomy, and office equipment all had alphas below 0.65.[16] Besides being translated into Arabic and Greek, it was also translated to Sinhalese language.[23]

The test–retest was used to evaluate reliability (stability). The test–retest coefficients of MUEQ were desirable (higher than 0.7). It means that the tool in the different conditions, to what extent gives the same results. In the present study, it shows the stability of the responses.

Our Persian MUEQ in the case of work environment and body posture scales had a weak direct correlation with the NMQ, which is because of the existing correlation between the risk factor of body posture and the work environment with the prevalence of MSDs in computer users. Due to the lack of a common risk factors questionnaire for MSDs in computer users in Iran, we used NMQ as a prevalence assessment but very popular tool. Therefore, because the structure and questions of these two tools were somewhat different, the correlation was weak. MUEQ measures the risk factors of various factors, but the NMQ measures the symptoms of MSDs. It should be noted that according to the results of this section, ergonomic interventions in these two areas of posture and work environment should be more considered.

The results also showed that the highest prevalence of pain and other medical complaints has been reported in the neck, lower back, and back. The lowest prevalence of complaints has been in the ankle region. Other studies have confirmed this finding. For example, one study in Industrial University of Santander, Colombia among office workers has reported symptoms in the neck and lower back by using NMQ.[25] In Khodabakhshi *et al*.'s study also, the most common discomfort was in the neck, shoulders, back, wrists, elbow, and knee, respectively, among Iranian population; therefore, our findings are also consistent with those of others.[26] The 1-year prevalence of MSDs among computer users was derived from cross-sectional descriptive studies. However, cohort studies are necessary to find the correct relationship between ergonomic and psychosocial causes with the occurrence of MSDs. Several studies proposed educational and ergonomic intervention for reducing MSDs.[27-30] Our study highlighted the importance of this intervention in the neck, upper and lower back, and knee.

Limitations

Because of the yes/no questions in workstation scale, we have omitted this scale for using factor analysis. We think that additional cultural validation and criterion validity are necessary for the tool to be completed.

Conclusion

The purpose of this study was to determine the psychometric properties of the MUEQ in computer users. Accordingly, the tool examines the nature of the physical and psychological factors associated with neck and shoulder complaints in computer users. The study showed that the tool has a desirable level of validity and reliability and can be used to measure musculoskeletal discomfort and complains of the computer user community in the country. Considering that the validity and reliability indicators of the questionnaire were all reported desirable, this questionnaire can be used as a reliable and valid tool for measuring musculoskeletal problems.

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Conflicts of interest

There are no conflicts of interest.

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