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Turkish version of the Cornell Musculoskeletal Discomfort Questionnaire: Cross-cultural adaptation and validation

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Abstract. *Objective:* This study documented the cross-cultural adaptation, validity, and reliability of the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) in the Turkish language.
Participants: The participant group included 48 Turkish workers.
Methods: The cross-cultural adaptation included the translation, synthesis, back-translation, expert committee review and pretest stages. The adapted Turkish version of the CMDQ (T-CMDQ) was validated through self-administration of the tool and a Visual Analog Scale (VAS) among participants.
Results: The validity of the T-CMDQ was good; Kappa coefficients between the responses given on the VAS and on the T-CMDQ indicated substantial to almost perfect agreement (ranged between 0.62–0.92 across body parts), and Spearman rank correlation coefficients between the VAS scores and T-CMDQ severity scale responses were all significant (ranged between 0.46–0.83 across body parts). Test-retest reliability of the T-CMDQ was satisfactory; Kappa coefficients, which ranged between 0.56–0.97 across the three scales, indicated moderate to almost perfect agreement between test-retest responses across body parts.
Conclusions: This study produced the T-CMDQ with good psychometric properties, presented the first formal validation of the CMDQ and provided useful insights on the cross-cultural adaptation process of a subjective data collection tool which was originally developed in English, into the Turkish language.

Keywords: Data collection tool, scale, assessment, work interference, reliability

1. Introduction

Due to the severe effects on health and productivity of the workforce, assessment of musculoskeletal symptoms among working population has gained significant importance on a global scale [1–15]. Assessment of musculoskeletal symptoms is also an integral part of ergonomic interventions and programs that aim to reduce musculoskeletal disorders and to improve worker health and performance [16–21]. To perform effective and accurate assessments, applicable, valid and reliable tools should be employed in collecting symptom data. [3,4,25–27,29]. Questionnaires are widely used for the assessment of musculoskeletal symptoms as self-administered, cost-effective and practical data collection tools [3–5,8–10,13–17,22]. Using questionnaires in data collection allows one to record the location, frequency, severity and work performance outcomes of musculoskeletal symptoms such as pain or discomfort [23,24,29].

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Most questionnaires for musculoskeletal symptoms are developed, however, in the English language for the English-speaking populations. Researchers in countries speaking languages other than English, such as Turkey, have two choices. The first choice is to develop a new questionnaire in their native language [15,21]. The second choice is to cross-culturally adapt the questionnaires that have been developed in English into their language [3,14,28]. Development of a new questionnaire can be more time-consuming than cross-cultural adaptation of the questionnaires that have been developed and validated in the English language. Furthermore, cross-culturally adapted questionnaires enable researchers to compare the data gathered from two populations [28]. Thus, cross-cultural adaptation of questionnaires developed in English into other languages has become a widely accepted practice [28,30].

The Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) is a data collection tool developed in the Human Factors and Ergonomics Laboratory at Cornell University for the assessment of musculoskeletal symptoms among the English-speaking workforce [31,32]. CMDQ addresses the frequency, severity and work interference of musculoskeletal discomfort (MSD) across 20 body parts. Inclusion of the work interference component makes CMDQ suitable for studies that aim to assess work performance outcomes as well as the extent of MSD among working populations. Recent applications of the CMDQ include the assessment of the MSD among nursing personnel [24] and data entry workers in a telecommunication company [23].

There has been a certain need for an applicable, valid and reliable questionnaire for the assessment of the extent and the work performance outcomes of musculoskeletal symptoms among the Turkish-speaking workforce. It was thought that the CMDQ could meet this need. Therefore, the current study aimed to cross-culturally adapt the CMDQ into the Turkish language and to establish the validity and reliability of the Turkish version of the questionnaire among a target group of Turkish workers.

2. Cross-cultural adaptation

2.1. The Cornell Musculoskeletal Discomfort Questionnaire

The CMDQ involves self-rating of the frequency, severity and work interference of the MSD on three scales across 20 body parts. The responses given on the frequency, severity and work interference scales can be used in computations as percentages [23] or can be given weights. On the frequency scale, the frequency of experiencing MSD in the past work week is rated across the following anchors: *'Never', '1–2 times last week', '3–4 times last week', 'Once every day'* and *'Several times every day'* with weights of 0, 1.5, 3.5, 5, and 10, respectively. On the severity scale, the severity of the experienced MSD is rated across the following anchors: *'Slightly uncomfortable', 'Moderately uncomfortable'* and *'Very uncomfortable'* with weights of 1, 2, and 3, respectively. On the work interference scale, the interference of the experienced MSD with ability to work is rated across the following anchors: *'Not at all', 'Slightly interfered'* and *'Substantially interfered'* with weights of 1, 2 and 3, respectively. Male and female versions of the CMDQ for standing and sedentary workers, and a similar version of the questionnaire specific for hand symptoms (i.e. Cornell Hand Discomfort Questionnaire) [23] are available from the Cornell University Ergonomics Web site [32]. The male version of the CMDQ for standing workers is presented in Fig. 1.

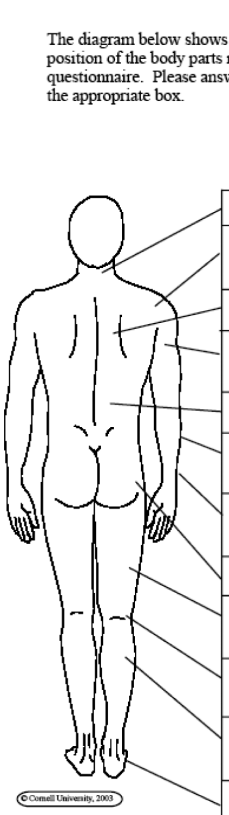
Cross-cultural adaptation of the CMDQ into the Turkish language was carried out in accordance with the guidelines developed by Beaton et al. [28]. The guidelines included a six-stage methodology for the cross-cultural adaptation of health-related subjective data collection tools. The CMDQ for standing workers was used in the adaptation process in that this version included "*foot*" (i.e., with right-left distinction) among body parts which was not included in the CMDQ for sedentary workers. A description of the stages of cross-cultural adaptation follows.

2.2. Translation

Translation of the CMDQ into the Turkish language was made by two native Turkish translators. Both of the translators had a high command of English. One of the translators (i.e., the third author) was a physical therapy and rehabilitation specialist who was familiar with the musculoskeletal disorders and the concept of the study. The other translator was an industrial engineer who was not familiar with the concept of the study (i.e., a naïve translator). Translations were made independently and both translators produced a written translation report.

2.3. Synthesis

The translators and the first author synthesized the Turkish translations of the CMDQ in a meeting. Three



The diagram below shows the approximate position of the body parts referred to in the questionnaire. Please answer by marking the appropriate box.		During the last work week how often did you experience ache, pain, discomfort in:					If you experienced ache, pain, discomfort, how uncomfortable was this?			If you experienced ache, pain, discomfort, did this interfere with your ability to work?		
		Never	1-2 times last week	3-4 times last week	Once every day	Several times every day	Slightly uncomfortable	Moderately uncomfortable	Very uncomfortable	Not at all	Slightly interfered	Substantially interfered
Neck		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Shoulder	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Upper Arm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Back		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Forearm	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Wrist	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hip/Buttocks		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Thigh	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knee	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lower Leg	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Foot	(Right)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Left)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Fig. 1. Male version of the CMDQ for standing workers.

issues were addressed. The first issue was the definitions of "*upper arm*", "*forearm*", "*thigh*" and "*lower leg*". In the spoken Turkish language, the upper and lower parts of the arms and legs are not expressed with different terms such as forearm or thigh. Instead, the upper and lower regions of the arms and legs are expressed by indicating the associated body region with gestures. Furthermore, the Turkish synonyms of the forearm and the thigh are used in medical literature, but not in the spoken Turkish language. Hence, it was decided to use side-definitions indicating the associated body region along with the Turkish synonyms of "*upper arm*", "*lower arm*", "*upper leg*" and "*lower leg*". For example: the phrase "*between shoulder and elbow*" was added to "*upper arm*". The second issue was the question for the frequency scale, based on each body part: "*During the last work week how often did you experience ache, pain, discomfort in...*". The structure of this sentence was not applicable in the Turkish language. Instead, it was decided to use the Turkish version of the sentence: "*During the last work week how often did you experience ache, pain, discomfort?*", followed by the Turkish version of the sentence: "*Answer for each body part*". The third issue was the use of naked body diagrams in the original versions of the questionnaire. In the Turkish culture, it would likely be deemed inappropriate to communicate using naked body diagrams during prospective studies, particularly among people with low education levels. Therefore, a professional graphic designer modified the naked body diagrams in the original versions of the CMDQ into clothed diagrams. Consequently, an agreed-upon Turkish translation of the CMDQ and a written report were produced.

2.4. Back translation

The synthesized Turkish version of the CMDQ was provided to two back-translators. One of the translators was from a bi-lingual family; her mother was American and father was Turkish, which contributed to her command of the languages and the cultures of the both populations. The other back-translator was an American who had been working in Turkey for two years. Both of

the back-translators were language professionals working in a publishing company. The back-translators were blind to the original version of the CMDQ and were not informed about the concept of the study. They made the back translations independently and both of the back-translators produced a written back translation report.

2.5. Expert committee review

The expert committee was comprised of the translators, the back-translators, the first author (i.e., the methodologist), as well as the second author (i.e., an occupational health specialist) and a company doctor who had knowledge and experience about the concept of the study. The expert committee reviewed the original and the translated versions of the questionnaire. The committee found insertion of the side-definitions for the aforementioned body parts, the modifications to the question sentence on the frequency scale, and the clothing modifications to the naked body diagrams suitable. Based upon their experience in the Turkish culture, the back-translators particularly supported the clothing modifications to the body diagrams. At the end of the review, the Turkish draft version of the CMDQ was produced and the committee reached a consensus about equivalence (i.e., semantic, idiomatic, experiential, and conceptual equivalence), understandability, and applicability of the Turkish draft version of the questionnaire. Five subjects reviewed the Turkish draft version of the CMDQ and found the face validity of the questionnaire satisfactory, which concluded the expert committee review.

2.6. Pretest

The Turkish draft version of the CMDQ was pretested by 20 subjects (15 males, five females) with various educational and occupational profiles. The proportions of elementary school, high school and university graduate subjects were 45%, 50%, and 5%, respectively. The subject group included manufacturing workers, office employees and cleaning service employees with the proportions of 60%, 15%, and 25%, respectively.

Each subject was given a brief introduction and asked to fill out the Turkish draft version of the CMDQ independently. After this, each subject was interviewed about the clarity and understandability of the questionnaire. None of the subjects reported any problem. Subsequently, the returned questionnaires were reviewed to identify the missing and inconsistent responses, based on two criteria. First, the participants were expected to give responses for all 20 body parts. Second, the participants were expected to respond to three scales as required. That is, if a participant reported discomfort for a body part through choosing an anchor other than "*Never*" on the frequency scale, that person was expected to respond to both the severity and the work interference scales as well. Responses failing to meet these criteria were classified as missing data for the associated body part. Consistency was sought among the responses given on the three scales for each body part. If a participant responded "*Never*" on the frequency scale for a body part, that person was expected not to respond to other two scales for the associated body part. The subjects did not report problems about clarity and understandability of the questionnaire. However, the total proportion of the missing and inconsistent responses on item basis (i.e., each body part being an item and the total number of items to be completed by 20 participants amounting to 400) was 39% (i.e., 155 items). Most of the missing and inconsistent responses were on the body parts with left-right distinction as well as on the severity and the work interference scales.

The total proportion of the missing and inconsistent responses was considerable. Therefore, the expert committee, with the exception of the back-translators, discussed potential causes leading to missing and inconsistent responses. It was considered that the Turkish population might need more visual orientation on the layout of the questionnaire. Thus, it was decided to orient subjects more effectively across body parts (i.e., vertically) and the severity and the work interference scales (i.e., horizontally) by incremental modifications. For the vertical orientation: the body parts were separated with blank lines, the anchors for the right-left sections of the body parts were separated with a line where necessary (e.g., shoulder, forearm), and the terms "*right*" and "*left*" and the sentence "*Answer for each body part*" on the frequency scale were written in boldface. For the horizontal orientation: the backgrounds of the severity and the work interference scales were colored in different tones of gray and the phrase "*If you experienced ache, pain, discomfort. . . "* on these scales was written in boldface. The revised Turkish draft version of the CMDQ was approved by the committee and visually reviewed by the same subject group. Visual orientation on the revised draft version of the questionnaire was found to be satisfactory and the cross-cultural adaptation process was completed.

2.7. Submission of documents to the developers of the CMDQ

After completion of the validation stage, the Turkish version of the CMDQ (T-CMDQ) and the research report about the cross-cultural adaptation, validity and reliability of T-CMDQ (i.e., Section 3) were submitted to and approved by Professor Alan Hedge, the developer of the original questionnaire. Male and female versions of the T-CMDQ for standing workers are presented in Fig. 2.

3. Validity and reliability of the T-CMDQ

3.1. Participants

The validity and reliability of the T-CMDQ were measured via application of the questionnaire with 52 workers of a manufacturing company located in Istanbul. All participants were Turkish and participation was voluntary. The questionnaires returned by four participants were invalid and the final participant group included 48 workers. The participant group consisted of 39 males (81.3%) and 9 females (18.7%). Age of the participants ranged between 23–56 years with a mean age of 36.21 (S.D. 7.87) years. The number and proportions of the participants with primary school or lower, secondary school, high school, and university or higher education levels were 11 (22.9%), 8 (16.7%), 17 (35.4%), and 12 (25.0%), respectively.

3.2. Materials and methods

3.2.1. Validity

Visual Analog Scale (VAS) has been widely used in validation of health-related questionnaires [33,34]. To measure the concurrent validity of the T-CMDQ, the participants filled out a VAS of 100 mm. (i.e., No ache, pain, discomfort at all: '0', Very severe ache, pain, discomfort: '100') along with the questionnaire and the validity of the questionnaire was examined in two ways. First, a Kappa coefficient measured the agreement between the responses given on the VAS and on the T-CMDQ frequency scale. The participants who reported discomfort on the VAS were expected to report discomfort on the T-CMDQ frequency scale as well. By the same token, those who did not report discomfort on the VAS were also expected to respond "*Never*" on the T-CMDQ frequency scale. Second, Spearman rank correlation established the correlation between the VAS scores and the T-CMDQ severity scores and the VAS scores were expected to correlate positively with the T-CMDQ severity scores.

3.2.2. Reliability

Test-retest reliability and the internal consistency of the T-CMDQ were measured simultaneously. To measure the test-retest reliability, the participants were asked to fill out the T-CMDQ twice with a time interval ranging between 7–10 days [35]. None of the participants had medical operation or treatment between two tests. Test-retest reliability was analyzed by calculating Kappa coefficient for the agreement between the test-retest responses given on the frequency, the severity and the work interference scales separately. Internal consistency of each scale was assessed by calculating Cronbach's alpha statistic.

3.3. Results

The total proportion of the missing and inconsistent responses given on test-retest of the T-CMDQ was 8.9% including four invalid questionnaires. The validity and reliability assessments were made by using the valid responses for each body part (Table 1).

3.3.1. Validity

Kappa coefficients which measured the agreement between the responses given on the VAS and on the T-CMDQ frequency scale ranged between 0.62–0.92 across body parts. Spearman rank correlation coefficients that established the correlation between the VAS scores and T-CMDQ severity were all significant ($p < 0.005$) and ranged between 0.46–0.83 across body parts.

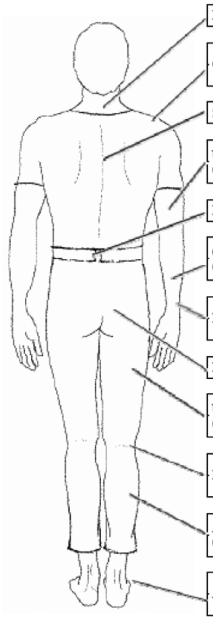
3.3.2. Reliability

Kappa coefficients which measured the agreement between the test-retest responses ranged between 0.56–0.95, 0.56–0.97 and 0.59–0.94 for the frequency, the severity and the work interference scales respectively. Cronbach's alpha statistics for the frequency, the severity, and the work interference scales were 0.88, 0.89, and 0.88, respectively.

4. Discussion

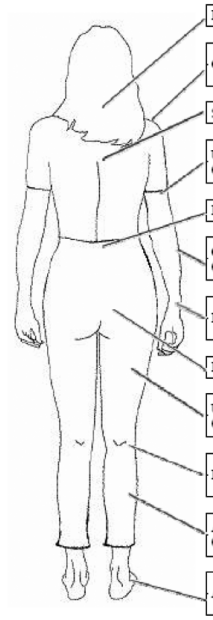
The objective of the current study was to cross-culturally adapt the CMDQ in the Turkish language and to validate the Turkish version of the questionnaire.

The cross-cultural adaptation sought to produce a clear and understandable Turkish version of the questionnaire through participation of a multi-disciplinary group of researchers, language professionals and health



Aşağıdaki resim, ankette sorulan vücut bölümlerini yaklaşık olarak göstermektedir. Lütfen uygun kutucuğu işaretleyerek cevaplayınız.		Geçtiğimiz hafta çalıştığınız süre boyunca, vücudunuzda ne sıklıkta ağrı, sızı, rahatsızlık hissettiniz? (Her vücut bölümü için cevaplayınız)					Eğer ağrı,sızı,rahatsızlık hissettiyseniz, ne kadar şiddetliydi?			Eğer ağrı,sızı,rahatsızlık hissettiyseniz, bu işinizi yapmanıza engel oldu mu?		
		Hiç hissetmedim	Hafta boyunca 1-2 kez hissettim	Hafta boyunca 3-4 kez hissettim	Her gün bir kez hissettim	Her gün bir çok kez hissettim	Hafif şiddetliydi	Orta şiddetliydi	Çok şiddetliydi	Hiç engel olmadı	Biraz engel oldu	Çok engel oldu
Boyun		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Omuz	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sırt		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Üst Kol (omuz - dirsek arası)	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bel		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ön Kol (dirsek - bilek arası)	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
El Bileği	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kalça		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Üst Bacak (kalça - diz arası)	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Diz	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Alt Bacak (diz - ayak arası)	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ayak	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

(a) Male version of the T-CMDQ for standing workers



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		Hiç hissetmedim	Hafta boyunca 1-2 kez hissettim	Hafta boyunca 3-4 kez hissettim	Her gün bir kez hissettim	Her gün bir çok kez hissettim	Hafif şiddetliydi	Orta şiddetliydi	Çok şiddetliydi	Hiç engel olmadı	Biraz engel oldu	Çok engel oldu
Boyun		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Omuz	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sırt		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Üst Kol (omuz - dirsek arası)	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Bel		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ön Kol (dirsek - bilek arası)	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
El Bileği	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kalça		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Üst Bacak (kalça - diz arası)	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Diz	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Alt Bacak (diz - ayak arası)	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ayak	(Sağ)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	(Sol)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

(b) Female version of the T-CMDQ for standing workers

Fig. 2. (a) Male version of the T-CMDQ for standing workers; (b) Female version of the T-CMDQ for standing workers.

Table 1
Validity and test-retest reliability assessment results

Body parts		Validity		Test-retest reliability		
		Agreement between VAS & T-CMDQ Freq.scale	Correlation between VAS & T-CMDQ Severity scores	T-CMDQ Frequency scale	T-CMDQ Severity scale	T-CMDQ Work Int. scale
	n	Kappa	Spearman	Kappa	Kappa	Kappa
Neck	48	0.79	0.82*	0.74	0.78	0.75
Right shoulder	46	0.74	0.67*	0.70	0.74	0.68
Left shoulder	47	0.62	0.46*	0.74	0.78	0.74
Upper back	45	0.73	0.77*	0.64	0.56	0.64
Right upper arm	46	0.69	0.52*	0.78	0.77	0.74
Left upper arm	46	0.74	0.59*	0.84	0.83	0.77
Lower back	43	0.63	0.70*	0.56	0.57	0.59
Right forearm	48	0.67	0.49*	0.75	0.69	0.69
Left forearm	46	0.69	0.46*	0.77	0.74	0.71
Right wrist	48	0.71	0.48*	0.69	0.69	0.66
Left wrist	46	0.74	0.49*	0.75	0.74	0.74
Hip/Buttocks	48	0.92	0.83*	0.95	0.97	0.94
Right thigh	47	0.83	0.76*	0.81	0.83	0.83
Left thigh	44	0.82	0.49*	0.88	0.88	0.86
Right knee	47	0.70	0.60*	0.62	0.66	0.63
Left knee	47	0.79	0.67*	0.68	0.69	0.74
Right lower leg	48	0.79	0.77*	0.74	0.78	0.75
Left lower leg	48	0.75	0.67*	0.74	0.78	0.83
Right foot	48	0.71	0.67*	0.71	0.72	0.69
Left foot	48	0.79	0.68*	0.77	0.81	0.75

$*p < 0.005$.

professionals. Minor modifications were made to the text (e.g., adapting question sentence on the frequency scale) and layout (e.g., clothing modifications to body diagrams, separating body parts with blank lines) of the questionnaire. These modifications substantiated the importance of a cross-cultural approach for incorporating cultural differences in the adaptation of data collection tools into different languages. The cross-cultural adaptation guidelines [28] followed in the current study provided a useful roadmap for the adaptation process and the study exemplified cross-cultural adaptation of a subjective data collection tool which was originally developed in English, into the Turkish language. Consequently, the study produced the Turkish version of the CMDQ which can be self-administered with acceptable rate of missing and inconsistent responses.

Psychometric properties of the T-CMDQ were satisfactory. The questionnaire demonstrated good validity: Kappa coefficients indicated substantial to almost perfect agreement between the responses given on the VAS and on the T-CMDQ frequency scale [36], and Spearman correlation coefficients indicated significant positive correlations between VAS scores and the T-CMDQ severity scores across all body parts. Magnitude of positive correlations was strong for neck and hip/buttocks, and nearly moderate and moderate for the remaining body parts [38]. Test-retest reliability of the T-CMDQ was satisfactory: Kappa coefficients indicated that test-retest responses on all three scales of the lower back and on the severity scale of the upper back were in moderate agreement, whereas test-retest responses on all scales across the remaining body parts were in substantial or almost perfect agreement [36]. Internal consistency of the T-CMDQ was good: Cronbach's alpha values were high for all three scales [37]. The original version of the CMDQ has not been formally validated: researchers are advised to check test-retest reliability of the questionnaire for their target groups and to test diagnostic validity of the questionnaire against clinical reports [32]. Thus, the current study introduces the first formal validity and reliability test of the CMDQ and abovementioned results indicate that the T-CMDQ can be used and interpreted with confidence among Turkish speaking work force. Furthermore, this study tested concurrent validity of the T-CMDQ using VAS scores and future studies can test diagnostic validity of the tool against clinical reports among Turkish population.

The T-CMDQ introduces certain qualities for assessment of musculoskeletal symptoms among work force. In the following, the qualities of the CMDQ were propounded, and compared with the Nordic Musculoskeletal Questionnaire (NMQ), to the authors' best knowledge, the most commonly used data collection tool for assessment of musculoskeletal symptoms [3,8–10,13,

14,29,39,40]. First, the T-CMDQ allows for identification of symptom location and assessment of frequency, severity and work interference of MSD specifically across 20 body parts for standing workers and 18 body parts for sedentary workers (i.e., feet are excluded) with left-right distinction where appropriate (e.g., shoulders) [23,24,32]. The NMQ has a general questionnaire section which collects data on the occurrence of musculoskeletal symptoms across nine body parts (i.e. neck, shoulders, upper back, elbows, low back, wrist/hands, hips/thighs, knees, and ankles/feet) during past 12 months and past seven days, as well as prevention from normal work (i.e., at home or away from home) due to experienced symptoms during past 12 months [29,39]. In further sections of the NMQ, questions are probed for deeper assessment of symptoms experienced in four body parts (i.e., neck, shoulder, low back, wrist/hand) [39]. In the NMQ, left-right distinctions are made only for shoulders, elbows, and wrist/hands. The T-CMDQ does not include elbows, but includes upper arm and forearm with left-right distinctions. The T-CMDQ includes wrists but not hands, as another questionnaire was developed (i.e. Cornell Hand Discomfort Questionnaire) for detailed assessment of hand discomfort [32]. The NMQ includes ankles/feet as a single body part, whereas the T-CMDQ includes lower legs and feet as separate body parts with left-right distinctions (i.e. sedentary workers version excludes feet). Thus, it can be claimed that the T-CMDQ allows for a detailed and extensive assessment of the symptom location.

Second, the T-CMDQ enables researchers not only to screen the occurrence of MSD, but also to score the extent and work performance outcomes of MSD across body parts [23,24] by using weighted responses (i.e. Section 2.1). The product of the weighted responses on the three scales gives a weighted score for each body part which ranges between 0 (i.e., *'Never'* on the frequency scale) and 90 (i.e., 10 on the frequency scale x 3 on the severity scale x 3 on the work interference scale) [32]. Moreover, the sum of the weighted scores across all body parts gives a total score which indicates the person's overall MSD status. In the NMQ, anchors are dichotomous in the general questionnaire section [29,39]. For instance, in the symptom occurrence scale of the NMQ, the question '*Have you at any time during the last 12 months had trouble in neck?*' is asked to be responded with Yes/No anchors [29,39]. Prevention from work due to experienced MSD is asked to be responded with Yes/No anchors in the general questionnaire section as well [29,39]. This dichotomous structure allows one to screen only the occurrence of MSD and the prevention from normal work (i.e., at home or away from home) due to MSD experienced in the associated body part. The frequency of symptoms and extent of work performance effects of MSD is asked to be rated in further questionnaire sections for only four body parts. Using the T-CMDQ weighted scores allows for comparative assessments of symptoms, such as comparison of mean MSD frequency for neck among different samples. By using the T-CMDQ weighted scores, researchers can monitor changes not only in the occurrence but also in the extent and effects of MSD before-after workplace interventions, such as assessment of reduction in frequency, severity and work interference of neck symptoms after installation of ergonomic furniture among office workers. Furthermore, the associations between frequency and severity of MSD, and work interference of MSD for a body part, and correlations between musculoskeletal symptoms experienced across body parts can be investigated using the T-CMDQ weighted scores.

A salient difference between the T-CMDQ and the NMQ is the time frame [24]. The T-CMDQ addresses symptoms experienced in the past work week [32]. On the other hand, the NMQ addresses MSD experienced in two different time frames; past 12 months and past seven days on separate scales. Using these two time frames in the NMQ allows one to differentiate between chronic musculoskeletal problems sustained in the past year and acute problems experienced in the past week [29,39]. However, it was argued that recent symptoms are prone to be remembered better which alleviate the usefulness of assessment made for a long time frame such as 12 months [29]. Nevertheless, the T-CMDQ can effectively identify recent musculoskeletal symptoms and can be periodically repeated to monitor MSD in longer terms.

The current study involved certain limitations. First, participants filled out the T-CMDQ twice with an acceptable time interval ranging between 7–10 days in test-retest applications [35], however, the responses were not collected on the same day of the week and same time of the day. This could have affected the consistency of the responses. Second, the concurrent validity of the T-CMDQ was established at a satisfactory level, whereas validity of the tool was not checked against the clinical reports [32]. Checking its validity against clinical reports in future studies could be useful to further determine the psychometric quality of the questionnaire.

Using applicable, valid, and reliable data collection tools is important to assess musculoskeletal symp-

toms among the working population effectively [25–29]. Researchers and practitioners can confidently use the T-CMDQ to assess the extent and the work interference of musculoskeletal symptoms among the Turkish-speaking work force. The T-CMDQ can serve various research purposes. First, it can be used to assess musculoskeletal symptoms among various Turkish-speaking occupational groups who are exposed to musculoskeletal risks such as textile workers [17] or computer workers [41]. Second, the questionnaire can be used to assess the changes in extent and work interference of MSD after ergonomic interventions [42]. Third, the associations between individual, physical and psychosocial risk factors and MSD can be investigated using the T-CMDQ in cross-sectional studies [23]. Next, the questionnaire can be used by international companies which have workforces in both English-speaking countries and in Turkey. Finally, the CMDQ and T-CMDQ can be used in combination to assess and to compare musculoskeletal symptoms between English-speaking and Turkish-speaking populations from the same occupational groups.

The current study produced the Turkish version of the CMDQ with good psychometric properties. The study presented the first formal validation of the questionnaire. Furthermore, the study provided useful insights on the cross-cultural adaptation process of a subjective data collection tool which was originally developed in English, into the Turkish language. Soft copies of the male and female versions of the T-CMDQ for standing and sedentary workers are available from the Cornell University Ergonomics Web site [32].

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