German Version of the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ): Translation and Validation

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Abstract (150-250 words)

Purpose: Musculoskeletal disorders are a public health problem with significant effects on the work ability. In the context of work-related health promotion and prevention, there is a need of valid methods for the assessment of musculoskeletal pain and complaints, which are simple, time-saving and universally applicable. The aim of this study was the translation of a suitable questionnaire into German and the validation of the German version.

Methods: The linguistic and cultural adaption of the English Cornell Musculoskeletal Discomfort Questionnaire into German (D-CMDQ) followed international guidelines. The adapted version was initially tested in terms of comprehensibility on 44 persons with different educational and occupational backgrounds. The questionnaire was validated further on 68 employees with the reference of a Numeric Rating Scale (NRS). Finally reliability and internal consistency were verified.

Results: The D-CMDQ meets the requirements for comprehensibility and demonstrated a good validity. The values of Cohen's Kappa (0.38-1.00) and Spearman's rank correlation coefficient (0.40-1.00) reached, with one exception, substantial to excellent agreement. The Kappa values for the test-retest reliability were mainly in the moderate to substantial range (0.41-0.80) whilst taking the prevalence effect into account. The internal consistency (Cronbach's alpha: 0.75-0.82) was proven satisfactory.

Conclusion: The D-CMDQ meets the psychometric requirements for questionnaires. Its clarity and high economy make a broad application for different occupational groups possible, whether working physically, manually repetitive or mainly sedentary. With the D-CMDQ, a universal method for the assessment of musculoskeletal pain and complaints for the use in occupational medicine and prevention is available in the German-speaking world.

Keywords: Musculoskeletal disorders, pain assessment, questionnaires, validation study, work-related health promotion

Introduction

Musculoskeletal disorders and complaints (MSD) are a major public health problem (Picavet & Hazes, 2003). They often lead to an incapacity for work, cause high medical costs, and constitute an economic burden for society (Lee 1994; Stewart et al. 2003). In Germany, MSD caused almost one fourth of all sick leave (23.4%) and thus lead to a loss of approximately 21 billion Euros in gross value added in 2012 (BAuA 2014). For years, especially in occupational groups with high physical strain and rather modest payment, there has been an observable absenteeism. This absenteeism has frequently been caused by MSD and has lasted particularly long (Meyer et al. 2012; Schneider et al. 2006). Sectors which are particularly affected are the construction industry, as well as agriculture and forestry. However, musculoskeletal complaints play a major role for office workers as well (Janwantanakul et al. 2008). Independent of occurring physical stress, psychosocial stress such as high job demands, low job control, and low social support may increase the risk of MSD (Kim et al. 2014; Kraatz et al. 2013; Picavet and Hazes 2003).

MSD can have multiple causes and thus offers a wide range of preventive approaches consisting of ergonomic, work-organizational and psychosocial measures. Assessment tools are needed which are brief, valid and reliable to monitor the effectiveness of such preventive approaches and should be applicable in a wide variety of settings in order to acquire the impact of MSD on the current work ability.

In the past, well-established pain assessment tools have been developed for patients with chronic pain. These instruments are often long and time consuming and rarely take into account the impact of pain on the work ability. A common and valid method for the acquisition of pain intensity is the use of one-dimensional pain scales (such as numeric rating scales, verbal rating scales, visual analogue scales) which can be applied to different anatomical regions (Hjermstad et al. 2011; Strong et al. 1991). However, these scales do not consider aspects of function, including occupational activities. Commonly used questionnaires with functional outcomes are for instance the Roland-Morris Disability Questionnaire or the Oswestry Disability Index (Fairbank et al. 1980; Roland and Morris 1983). These tools, however, are limited to chronic low back pain and impairments in daily life. Other questionnaires handling office work focus solely on complaints in the arm and shoulder region as well as the neck area, as for example the RSI-QuickScan (Hoozemans et al. 2013). The Brief Pain Inventory (Cleeland and Ryan 1994) includes one pain interference item addressing work.

As opposed to the RSI-QuickScan, the commonly used Nordic Musculoskeletal Questionnaire acquires the presence of musculoskeletal complaints in nine relevant anatomical regions from the neck to the feet (Kuorinka et al. 1987). For the specific sections of the lower back, neck and shoulder region, the questionnaire additionally acquires information on the degree of pain as well as on the consequences of the disorder. A disadvantage of the Nordic Musculoskeletal Questionnaire is again that it is relatively time-consuming.

Compared with the above-mentioned questionnaires, the Cornell Musculoskeletal Discomfort Questionnaire (CMDQ) (Hedge et al. 1999), combines the frequency and the intensity of musculoskeletal pain and complaints with work-related impairments for 20 body regions in a chart on only one page. The CMDQ thus presents a highly economic method which is not only universally useable but also allows acquiring information on the functional aspects of office work and physically

demanding work, respectively. The CMDQ has been used for the evaluation of intervention studies concerning office work (Hedge et al. 2011; Rudakewych et al. 2001), in the health care system at work places for medical diagnostics (Hedge and James 2012), and in the field of nursing (Menzel et al. 2004). The questionnaire has originally been created in English. There exist already validated translations of the CMDQ into the Turkish language (Erdinc et al. 2011) and into Farsi (Afifehzadeh-Kashani et al. 2011).

For its usage in German-speaking countries as well as for the application of transnational research projects, the objective of our study was the translation of the Cornell Musculoskeletal Discomfort Questionnaire into German and the adaptation and validation of the German version (D-CMDQ).

Methods

Cross-cultural adaptation

In order to establish the cultural equivalence of the original version of the CMDQ, we followed previously published guidelines for translation and cross-cultural adaptation of health status measures (Beaton et al. 2000; Guillemin et al. 1993). The questionnaire was translated from English into German by two professional translators who worked independent of each other and whose native language is German. One of them was familiar with the concept of the questionnaire.

Then the written reports were discussed in a consensus panel to achieve the preliminary version.

The back translation of this version into the original language was done by another professional translator whose native language is English and by a German physician who has been living in the USA for 25 years. Afterwards, linguistic discrepancies as well as discrepancies in terms of content between the original version, the translation, and the back translation were discussed on the basis of a structured interview in a committee board. Subsequently, an interim final version was developed. Two translators, two occupational physicians, and two psychologists who were familiar with the intent of the measure and the concepts attended the committee board in order to create a review. Part of the review was the instruction of the questionnaire and the evaluation of the equivalence of steps within the scales.

Afterwards key words were underlined within the scales in order to improve the questionnaire's clarity. In a final step, the questionnaire's graphics were revised. In an earlier validation study (Erdinc et al., 2011) errors occurred during questionnaire completion due to mistakes in the horizontal dimension within the questionnaire. The lines representing single anatomical regions were thus marked-off by gray shades in the new version.

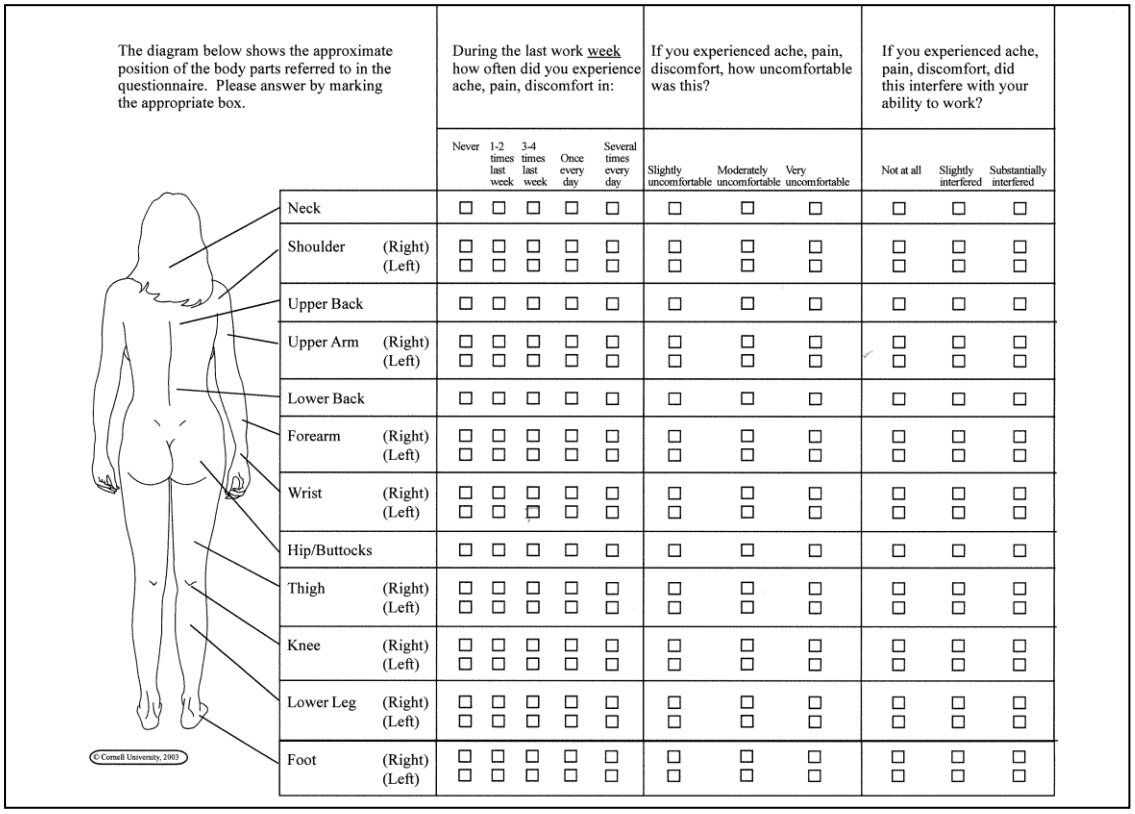

Figure 1: Female version of the originally CMDQ for standing worker

Pretest

The German version of the CMDQ (D-CMDQ) was pre-tested on 44 subjects aged 18-67 years. 59.1 % of them were female. The pretest's main purpose was to validate the comprehensibility of the adapted version, thus the pretest included subjects with different educational backgrounds and different occupations, for example kitchen porters, cleaners, office employees, musicians, students, and research assistants. The proportions of the subjects with high, intermediate, and low educational status were about 47.7 %, 31.8 %, and 20.4 %. The participants were informed about the purpose of the research study and asked to indicate occurring difficulties with regard to the instructions, the questionnaire's structure, or the comprehensibility of certain terms.

The answered questionnaires were reviewed with regard to completeness and inconsistent findings. The instruction of the questionnaire asked to provide information in *all* anatomical regions. Accordingly, even if there was no pain or complaints in certain anatomical regions, answering the question in the frequency scale "During the last work week how often did you experience ache, pain, discomfort?" the category "never" had to be checked. Omitted items were rated as missing data. If the subjects claimed to have experienced pain or constraints in the frequency scale (every category but "never"), they had to indicate corresponding information in the severity scale and work interference scale. Omitted items in the latter were rated as missing data as well.

Inconsistency was encountered when subjects claimed they did not feel pain or complaints in certain anatomical regions within the frequency scale ("never") but indicated severity and work interference for the same anatomical regions. Consistency, on the contrary, would have meant no specification for these anatomical regions within the latter scales.

Taken as a whole, none of the pretest's subjects claimed they have had difficulties with regard to clarity and comprehensibility when filling-in the questionnaire. In some cases, items were omitted when subjects felt no complaints and thus left out certain anatomical regions within the questionnaire. Omitted items were the most frequent cause for missing data. With 20 items and 44 participants there were 880 possible items. In only 2% of all cases missing data occurred. Inconsistency was found in much more cases (15%).

The most frequent error was found when subjects answered the questions within the work interference scale „If you experience ache, pain, discomfort, did this interfere with your work ability?" with "not at all" although they had claimed earlier that they did not experience pain and discomfort. This, however, does not lead to a substantial contradiction. Knowing that the regional score, as suggested by Hedge, is calculated as the product (frequency x intensity x work interference) and "never" equates to the value "0", this error had no consequence, because in this case the result would remain "0" (Cornell University Ergonomics Web). For this reason, the expert committee decided against further modifications in this particular case.

Besides missing data and inconsistent findings, the study participants provided two further indications in the interviews. The first indication concerned the fact that pain regarding the elbow could not be directly assigned by all subjects. Furthermore it was apparent that a subdivision of the hip/buttocks in right-side and left-side would have been useful. Both indications have been added to the final version of the D-CMDQ after they had been discussed within the expert committee and after consultation with the developer of the CMDQ. Finally, the illustration of the female body was slightly modified in order to

visualize the neck area more precisely. Later the male version of the standing worker was adapted. By doing so, the cross-cultural adaption process was completed.

Validity assessment

Numeric Rating Scales (NRS) have been reported to yield reliable, valid, and sensitive measurements of pain intensity (Williamson and Hoggart 2005). For the validation of the D-CMDQ a 11-step NRS was used ranging from no pain (0) to worst imaginable pain (10). The study participants were asked to check the correct number describing the worst pain perceived during the last week for each body area. First of all, the responses regarding the occurrence of pain were compared between both questionnaires. It was examined whether all participants who had reported pain in the NRS did so in the D-CMDQ frequency scale as well. Those participants who had declared to have „no pain“ in the NRS were expected to check „never“ in the D-CMDQ frequency scale.

The agreement between the two methods was analyzed by Kappa coefficients (κ). There are different recommendations for the interpretation of the Kappa statistic (Altman 1991; Fleiss et al. 1981; Landis and Koch 1977). Kappa values of about 0.70 were found to be substantial. Values between 0.21 and 0.41 are believed to be fair, values between 0.41 and 0.60 are regarded as moderate (ibid.).

Afterwards the statistical dependence between the pain intensity assessed with the NRS and the D-CMDQ severity scale were analyzed by the Spearman rank correlation statistic. Spearman's correlation coefficients allow to analyze the strength of association between variables of ordinal measurement levels in a single value between -1 (negative association) and +1 (positive association). The values can be interpreted as follows: very low association between 0.00 and 0.20; low association between 0.20 and 0.50; moderate association between 0.50 and 0.70; high association between 0.70 and 0.90; very high association between 0.90 and 1.00. These values are considered to be recommendations. The interpretation of a value always depends on the scientific question (Brühl 2008)

Reliability assessment

Test-retest reliability for self-administrated tests is measured by presenting a questionnaire twice to a person separated by a given time interval in order to assess stability over time. In this study we decided to use a time interval of 7 days as a reasonable compromise between memory bias and clinical change.

First test-retest reliability was calculated by Spearman rank correlation coefficients using mean sum scores of each scale (frequency, severity scale, and work interference scale). In general high correlations can be expected for time-stable attributes only. Additionally Kappa coefficients were calculated to analyze the test-retest-reliability for the responses given on the frequency, the severity and the work interference scale for each body area separately. The Kappa value is influenced by the prevalence of the outcome (Byrt et al. 1993) and depends on the number of categories. The prevalence effect is related to the probabilities of "yes" and "no" and can lead to low Kappa values in the calculation of Kappa statistics by the Statistical Package for the Social Sciences (SPSS) despite of high agreement. Therefore we used a heuristic approach to overcome this problem by calculating a maximum Kappa (κ_{max}) for each measurement to compute the arithmetical ratio (κ/κ_{max}) subsequently

(Xier 2010). Kappa maximum is the highest obtainable agreement for a specific data set to relativize the Kappa correlation coefficient. Finally internal consistency of each scale was tested by calculating Cronbach's alpha statistic. For empirical investigations an alpha-lower limit of 0.70 is considered as satisfactory (Cortina 1993).

Statistics

All analyses were conducted using the IBM SPSS software, version 22.0 for Windows® (Statistical Package for the Social Sciences, Chicago, IL, USA). In all analyses, P values < 0.05 were considered as statistically significant.

Results

Sample

A convenience sample of 68 subjects of different professions participated in the validation process. All study participants were native German. The characteristics of the participants are shown in Table 1.

Table 1 Sociodemographic and work-related data of the subjects (n=68)

Characteristics	
Age (years)	44.8 ±12.6
>29	9 (13,2)
30-39	16 (23,5)
40-49	19 (27,9)
50-59	13 (19,1)
≥ 60	11 (16,2)
Gender	
Female	31 (45.6)
Male	37 (54.4)
Education	
Skilled worker	14 (20.6)
Vocational school	26 (38.2)
High school /technical school level	11 (16.2)
College level/ University	17 (25.0)
Professional situation	
Mainly physical workload	25 (36.8)
Mainly mental workload	43 (63.2)
Health condition	
Musculoskeletal disorders	60 (88,2)

Quantitative variables: mean ± standard deviation; Categorical variables: frequency (percentage)

In the initial examination, 88.2 % of all 68 participants reported musculoskeletal pain and complaints in at least one body part. More than three-fourth of all participants specified pain and complaints in two body parts. Most frequent were complaints in the lower back (54.4%), followed by complaints in the neck (38.2%) and the upper back (30.9%). Pain in the upper arm, elbow, thigh, and lower leg occurred rarely (<10%).

For the test-retest reliability complete data sets of 48 participants could be analyzed. None of the subjects reported a medical treatment or a change in medication between the two measurement points.

Validity

Table 2 shows the results of the validity assessment. Kappa coefficients demonstrate the agreement between the responses given on the NRS and on the D-CMDQ frequency scale and ranged from 0.38 (right thigh) to 1.00 (right foot). The association between the responses given on the NRS and the D-CMDQ severity scale obtained by Spearman's correlation coefficients ranged from 0.40 (right thigh) to 1.00 (right foot). All of these correlations were statistically significant ($p < 0.01$).

Table 2: Validity assessment results (n=68)

Validity		
Body parts	Agreement between NRS & D-CMDQ Frequency scale Cohen's Kappa	Correlation between NRS & D-CMDQ Severity scale Spearman rank correlation coefficients
Neck	0.97	0.97**
Right shoulder	0.96	0.97**
Left shoulder	0.96	0.97**
Upper back	0.83	0.80**
Right upper arm	0.64	0.64**
Left upper arm	0.92	0.93**
Lower back	0.94	0.89**
Right elbow	0.70	0.74**
Left elbow	0.65	0.70**
Right forearm	0.79	0.82**
Left forearm	0.66	0.70**
Right wrist	0.94	0.94**
Left wrist	0.88	0.89**
Right hip/buttocks	0.84	0.80**
Left hip/buttocks	0.88	0.90**
Right thigh	0.38	0.40**
Left thigh	0.65	0.67**
Right knee	0.91	0.96**
Left knee	0.96	0.95**
Right lower leg	0.79	0.80**
Left lower leg	0.85	0.86**
Right foot	1.00	1.00**
Left foot	0.93	0.94**

**p < 0.01; NRS = Numeric Rating Scale; D-CMDQ = German version of the Cornell Musculoskeletal Discomfort Questionnaire

Reliability

Regarding the internal consistency Cronbach's alpha statistics for the frequency, the severity, and the work interference scales were 0.75, 0.77, and 0.82, respectively.

The test-retest reliability calculated by Spearman rank correlation coefficients using a sum score of each scale was 0.56, 0.72, and 0.72 for the frequency, the severity, and the work interference scale, respectively.

Table 3 shows the association between test and retest responses at the level of the body parts (agreement of responses). Despite high agreement we found low Kappa values which are affected by the relative probabilities of the “yes” and “no” categories. Fortunately, in the presented study for the most body parts the number of subjects without pain was much higher than the number of subjects with pain. The calculation of the maximum Kappa was an approach to take into account the “prevalence effect” (Feinstein and Cicchetti 1990). The table also shows that in some body parts with low prevalence (proportion of “yes” responses) the values of the Kappa coefficients were “0” with both methods. In all cases the variable at the second measurement point was a constant (all subjects reported “no pain”). For these body parts a relative Kappa (κ/κ_{max}) could not be calculated.

Table 3: Test-retest reliability assessment results (n=48)

	D-CMDQ Frequency scale				D-CMDQ Severity scale				D-CMDQ Work interference scale			
Body parts	Agreement of responses	κ (SPSS)	κmax	κ/κmax	Agreement of responses	κ (SPSS)	κmax	κ/κmax	Agreement of responses	κ (SPSS)	κmax	κ/ κmax
Neck	73%	0.54	0.82	**0.66**	75%	0.56	0.76	**0.74**	77%	0.62	0.83	**0.75**
Right shoulder	79%	0.49	1.00	**0.49**	79%	0.46	0.91	**0.51**	81%	0.58	0.95	**0.61**
Left shoulder	90%	0.55	0.77	**0.71**	90%	0.55	0.77	**0.71**	88%	0.55	0.78	**0.71**
Upper back	77%	0.44	0.95	**0.46**	73%	0.40	0.82	**0.49**	75%	0.43	0.95	**0.45**
Right upper arm	87%	0.21	0.48	**0.43**	88%	0.22	0.36	**0.61**	88%	0.21	0.35	**0.60**
Left upper arm*	94%	0	0	**-**	94%	0	0	**-**	94%	0	0	**-**
Lower back	58%	0.34	0.70	**0.49**	62%	0.34	0.68	**0.50**	62%	0.41	0.70	**0.59**
Right elbow*	92%	0	0	**-**	92%	0	0	**-**	100%	0	0	**-**
Left elbow*	100%	0	0	**-**	100%	0	0	**-**	100%	0	0	**-**
Right forearm	91%	0.40	0.41	**0.98**	94%	0.55	0.56	**0.98**	94%	0.55	0.55	**1.00**
Left forearm*	92%	-0.21	0.49	**-0.43**	96%	-0.16	0.49	**-0.33**	96%	-0.16	0.49	**-0.33**
Right wrist	81%	0.58	0.86	**0.67**	81%	0.36	0.79	**0.46**	85%	0.50	0.79	**0.63**
Left wrist	92%	0.35	0.61	**0.57**	92%	0.22	0.61	**0.36**	92%	0.46	0.60	**0.82**
Right hip/buttocks	94%	0.68	1.00	**0.68**	94%	0.68	0.89	**0.76**	96%	0.78	0.89	**0.88**
Left hip/buttocks	100%	1.00	1.00	**1.00**	100%	1.00	1.00	**1.00**	100%	1.00	1.00	**1.00**
Right thigh	94%	0.55	0.56	**0.98**	94%	0.55	0.56	**0.98**	92%	0.40	0.56	**0.71**
Left thigh	93%	0.38	0.38	**1.00**	93%	0.38	0.38	**1.00**	92%	0.18	0.38	**0.47**
Right knee	88%	0.55	0.92	**0.60**	88%	0.55	0.73	**0.71**	85%	0.47	0.92	**0.51**
Left knee*	92%	0	0	**-**	92%	0	0	**-**	92%	0	0	**-**
Right lower leg*	96%	0	0	**-**	96%	0	0	**-**	96%	0	0	**-**
Left lower leg*	96%	-0.01	1.00	**-**	96%	-0.01	1.00	**-0.01**	96%	-0.02	1.00	**-0.02**
Right foot	96%	0.73	0.86	**0.85**	92%	0.46	0.86	**0.53**	96%	0.73	0.92	**0.79**
Left foot	92%	0.40	0.70	**0.57**	92%	0.39	0.85	**0.46**	94%	0.55	0.85	**0.65**

D-CMDQ= German version of the Cornell Musculoskeletal Discomfort Questionnaire; κ (SPSS) = Cohen's Kappa calculated with the Statistical Package for Social Sciences; κmax = maximum Kappa (Feinstein & Cicchetti 1990); * Variable at the second measurement point was a constant (all subjects reported "no pain"). For these body parts a relative Kappa (κ/κmax) could not be calculated.

Discussion

Musculoskeletal disorders and symptoms represent an important public health problem with special prominence for the workplace. Researchers have developed scales and questionnaires to evaluate location and intensity of pain as well as the functionality. Some of these methods are limited to special body parts for example the low back, other are more extensive but time consuming. Most methods do not include the impact of pain and discomfort on the work ability. This gap had been closed with the CMDQ (Hedge et al. 1999) which was developed in English for the application in the occupational sciences and validated for the Turkish and the Farsi version (Afifehzadeh-Kashani et al. 2011; Erdinc et al. 2011).

The current study presents a cultural adaptation of the English version of the CMDQ into German, following internationally respected methodological procedures, and finally the validation of the D-CMDQ.

The results of the pre-test indicate that the translated and adopted D-CMDQ meets the essential requirements for clarity and comprehensibility for persons with different educational and occupational background. This is a basic precondition for a universal application of a self-administrated questionnaire at the workplace. The percentage of missing data and inconsistent responses was found to be acceptable.

Regarding the psychometric properties, the D-CMDQ demonstrated good validity: with the exception of the right thigh, the Kappa values of all body areas reached the substantial range of agreement and 65% of all values were found to be excellent (Landis and Koch 1977). In the presented study the thighs belonged to the body parts for which the prevalence of symptoms were very low (about 5%). Therefore, differences between the responses in the frequency scale of the D-CMDQ and the Numeric Rating Scale had a stronger effect on the Kappa value than for those body parts with higher prevalence rates. In terms of the validity of the severity scale, Spearman correlation coefficients of all body areas showed a marked and significant association to the NRS (instead of the right thigh again) and in 74 % of the cases a high to perfect correlation was found. These results are comparable to the published data of the Turkish version of the CMDQ (Erdinc et al. 2011).

The Internal consistency of the D-CMDQ in this study was satisfactory with Cronbach's alpha values of 0.75 for the frequency scale, 0.77 and 0.82 for the severity and work interference scale. Nevertheless, the published values of Cronbach's alpha in the validation study of the Turkish version were higher (α = 0.88-0.89). In a recently conducted reapplication of the D-CMDQ in a sample of forestry workers (n = 88) we found alpha values of 0.88, 0.81, and 0.88 for the frequency, the severity and the work interference scale respectively.

Test-retest reliability of the D-CMDQ calculated by a total score of each scale indicated a markedly association. Nevertheless the item level high agreement of responses did not correspond with high Kappa values.

Since the introduction of the Kappa statistic some difficulties (paradoxes) associated with its interpretation have been described (Byrt et al. 1993; Cicchetti and Feinstein 1990; Feinstein and Cicchetti 1990). Originally, the Kappa statistic had been proposed for two observers scoring individuals as either positive or negative. Later the method has been extended for multiple observers and more than two categories. In the case of more than two categorical properties (e.g. five within the

CMDQ frequency scale), the opportunities for disagreement increase resulting in a lower Kappa value (Brennan and Silman 1992). For example, in comparison with the CMDQ the Nordic questionnaire for the analysis of musculoskeletal symptoms (Kuorinka et al. 1987) has only two categories for the assessment of symptoms in different body areas (yes/no). Therefore the calculation of the test-retest reliability results in higher Kappa values. To overcome this problem a weighted Kappa statistic (κ_w) has been proposed (Cohen 1968). For our data the calculation of a weighted Kappa did not lead to a relevant improvement of the Kappa values but the prevalence effect (Feinstein and Cicchetti 1990) achieved relevance.

The difference between the probabilities of "yes" and "no" referred to as the prevalence index (Byrt et al. 1993) affects the Kappa value. The larger the value of the prevalence index the smaller is Kappa (ibid.). For the data of the present study we decided to calculate the maximum Kappa to relativize the bias of prevalence according to the recommendations of Xier (2010). This method resulted in Kappa values which are in parts comparable with the results of the validation study of the Turkish version (Erdinc et al. 2011). In that study Kappa coefficients for the test-retest reliability ranged between 0.56-0.95, 0.56-0.97 and 0.59-0.94 for the frequency, the severity, and the work interference scale, respectively. The participants of the Turkish validation study were workers of a manufacturing company, 81.3 % of them were male. It might be that the subjects in this sample had a larger percentage of musculoskeletal symptoms and complaints, resulting in a smaller prevalence index and higher Kappa values. Indeed the published data were not specified regarding this assumption.

In summary it can be stated that for categorical data the interpretation of a single coefficient of agreement is difficult. For comparisons between agreement studies sometimes a more pragmatic approach is essential and in the case of kappa statistics observed agreement should be discussed as well as bias and prevalence.

Conclusions and implications for practice and research

Our results indicate that the adapted CMDQ is an appropriate method for the assessment of musculoskeletal disorders in the German-speaking work force. The psychometric properties of the D-CMDQ meet the requirements of validity and reliability. The questionnaire is characterized by high economy, clarity, and the possibility of universal application in different occupational groups.

Ethical approval: All procedures performed in studies involving human participants where in accordance with the 1964 Helsinki declaration or comparable ethical standards. Design and protocol of the study was approved by the local Ethics Committee and written informed consent was obtained from all participants included in this study.

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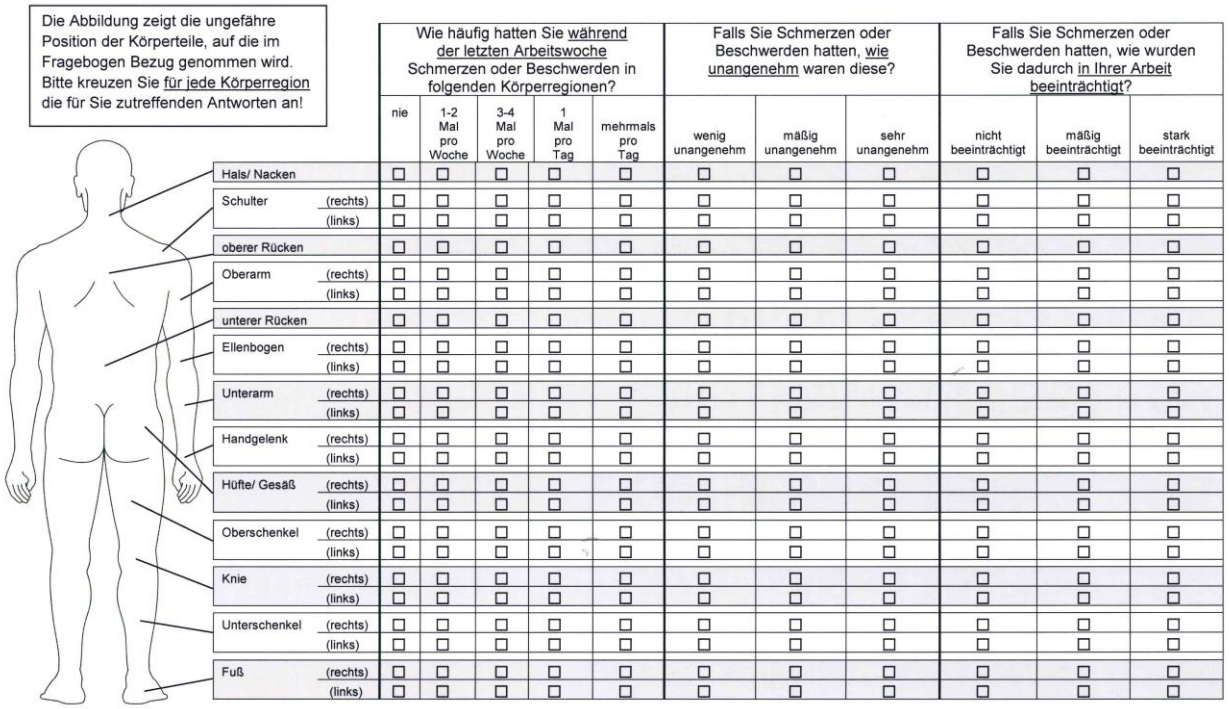
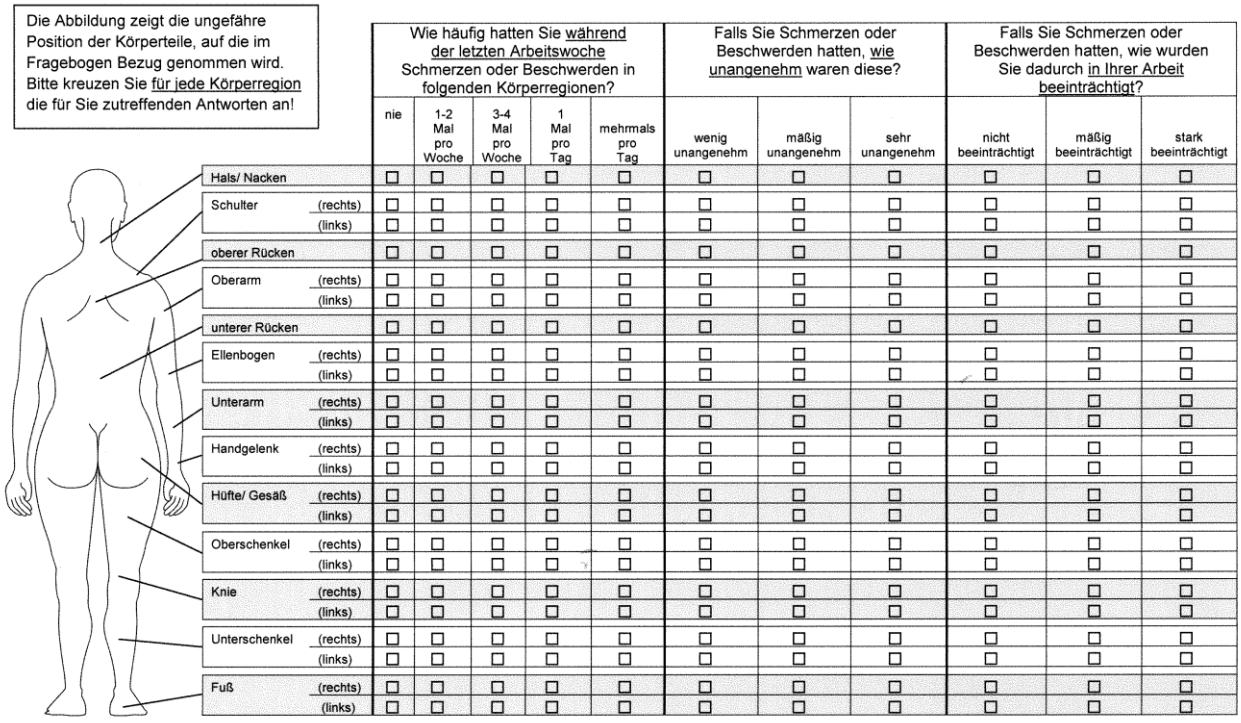
Conflict of interest
The authors declare that they have no conflicts of interest.



Die Abbildung zeigt die ungefähre Position der Körperteile, auf die im Fragebogen Bezug genommen wird. Bitte kreuzen Sie für jede Körperregion die für Sie zutreffenden Antworten an!

	Wie häufig hatten Sie während der letzten Arbeitswoche Schmerzen oder Beschwerden in folgenden Körperregionen?					Falls Sie Schmerzen oder Beschwerden hatten, wie unangenehm waren diese?			Falls Sie Schmerzen oder Beschwerden hatten, wie wurden Sie dadurch in Ihrer Arbeit beeinträchtigt?		
	nie	1-2 Mal pro Woche	3-4 Mal pro Woche	1 Mal pro Tag	mehrmals pro Tag	wenig unangenehm	mäßig unangenehm	sehr unangenehm	nicht beeinträchtigt	mäßig beeinträchtigt	stark beeinträchtigt
Hals/ Nacken	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Schulter (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Schulter (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
oberer Rücken	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Oberarm (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Oberarm (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
unterer Rücken	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ellenbogen (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ellenbogen (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unterarm (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unterarm (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Handgelenk (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Handgelenk (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hüfte/ Gesäß (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hüfte/ Gesäß (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Oberschenkel (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Oberschenkel (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knie (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knie (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unterschenkel (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unterschenkel (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fuß (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fuß (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Figure 2: Male version of the modified D-CMDQ



Die Abbildung zeigt die ungefähre Position der Körperteile, auf die im Fragebogen Bezug genommen wird. Bitte kreuzen Sie für jede Körperregion die für Sie zutreffenden Antworten an!

	Wie häufig hatten Sie während der letzten Arbeitswoche Schmerzen oder Beschwerden in folgenden Körperregionen?					Falls Sie Schmerzen oder Beschwerden hatten, wie unangenehm waren diese?			Falls Sie Schmerzen oder Beschwerden hatten, wie wurden Sie dadurch in Ihrer Arbeit beeinträchtigt?		
	nie	1-2 Mal pro Woche	3-4 Mal pro Woche	1 Mal pro Tag	mehrmals pro Tag	wenig unangenehm	mäßig unangenehm	sehr unangenehm	nicht beeinträchtigt	mäßig beeinträchtigt	stark beeinträchtigt
Hals/ Nacken	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Schulter (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Schulter (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
oberer Rücken	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Oberarm (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Oberarm (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
unterer Rücken	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ellenbogen (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ellenbogen (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unterarm (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unterarm (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Handgelenk (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Handgelenk (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hüfte/ Gesäß (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hüfte/ Gesäß (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Oberschenkel (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Oberschenkel (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knie (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knie (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unterschenkel (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Unterschenkel (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fuß (rechts)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Fuß (links)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Figure 3: Female version of the modified D-CMDQ

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