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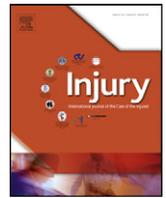
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## Cross-cultural adaptation of the Dutch Short Musculoskeletal Function Assessment questionnaire (SMFA-NL): Internal consistency, validity, repeatability and responsiveness

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### ABSTRACT

The purpose of this study was to translate and culturally adapt the Dutch version of the Short Musculoskeletal Function Assessment questionnaire (SMFA-NL) and to investigate the internal consistency, validity, repeatability and responsiveness of the translated version.

The original SMFA was first translated and culturally adapted from English into Dutch according to a standardised procedure and subsequently tested for clinimetric quality. The study population consisted of 162 patients treated for various musculoskeletal injuries or disorders at the departments of Orthopedics and Traumatology. All respondents filled in the SMFA-NL and the SF-36 and a region-specific questionnaire. To determine repeatability, 87 respondents filled in the SMFA-NL for a second time after a time interval of three to four weeks. To determine responsiveness, 29 respondents who were treated for their injury within three months before the first assessment filled in the SMFA-NL for a second time after two to three months. The following analyses were performed to evaluate clinimetric quality of the SMFA-NL: factor analysis and Cronbach's alpha (internal consistency), floor and ceiling effects, Spearman's Rho (construct validity), intraclass correlation coefficients and the Bland & Altman method (repeatability), and standardised response means (SRM) (responsiveness).

Factor analysis demonstrated four subscales of the SMFA-NL. Both the newly identified subscales of the SMFA-NL and the conventional subscales of the SMFA showed good internal consistency. No floor and some ceiling effects were found. Construct validity was good, as high correlations were found between the subscales of the SMFA-NL and the respective subscales of the SF-36 and the region-specific questionnaires. Repeatability of the SMFA-NL subscales was high, with no systematic bias between first and second assessment. Responsiveness of the SMFA-NL was moderate, as small to moderate SRMs were found.

We successfully translated and culturally adapted a Dutch version of the Short Musculoskeletal Function Assessment questionnaire (SMFA-NL). This study shows that the SMFA-NL is a valid, reliable and moderately responsive method for the assessment of functional status of patients who have a broad range of musculoskeletal disorders. Furthermore, it will allow for comparison between different patient groups as well as for cross-cultural comparisons.

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### Introduction

Musculoskeletal injuries and disorders are a major cause of morbidity throughout the world, having a substantial influence on health and quality of life and inflicting an enormous burden of cost on health systems.<sup>1</sup> Patient outcome questionnaires are essential in

both clinical practice and clinical research, to evaluate outcome after conservative or surgical treatment of musculoskeletal injuries or disorders. Numerous disease-specific or region-specific patient-reported questionnaires are used for this purpose.<sup>2–6</sup> However, when one wishes to evaluate and compare outcome amongst different groups of patients or patients with multiple injuries, these questionnaires are not suitable. The Short Musculoskeletal Function Assessment (SMFA) was therefore developed by Swiontkowski et al.<sup>7</sup> The SMFA is a patient-reported questionnaire, designed to detect differences in functional status of patients who have a broad range of musculoskeletal disorders. The American version of the SMFA is proven to be a valid, reliable and responsive questionnaire.<sup>7</sup>

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The SMFA is also recommended by the American Academy of Orthopedic Surgeons (AAOS) for use in clinical practices to assess the effectiveness of treatment regimens and in musculoskeletal research settings to study the clinical outcomes of treatment.<sup>8</sup>

The SMFA is widely used in English-speaking countries. Translated versions of the SMFA in different languages are needed to allow for cross-cultural comparisons of outcome assessment. It is now recognised that if questionnaires are to be used across cultures, they must not only be translated well, linguistically speaking, but also be adapted culturally to maintain the content validity of the instrument.<sup>9</sup> There are several non-English versions of the SMFA available that are cross-culturally adapted,<sup>10–13</sup> but, to our knowledge there is no Dutch-language version of the SMFA. The purpose of this study was therefore to translate and culturally adapt the SMFA into Dutch and to evaluate the clinimetric properties of the Dutch version in terms of internal consistency, validity, repeatability and responsiveness.

## Materials and methods

The study was divided into two stages. First, the American version of the SMFA was translated into Dutch according to a standardised procedure.<sup>9</sup> Second, the translated version was tested for clinimetric quality in a prospective study. The local Institutional Review Board approved the procedures employed in this study.

### Translation process

The translation and cross-cultural adaptation of the SMFA into Dutch was performed according to the Guidelines proposed by Beaton et al.<sup>9</sup> This process is divided into five stages. In the first stage, two bilingual translators with Dutch as their mother tongue independently translated the SMFA into Dutch. These translations were synthesised in the second stage by the translators and two independent observers. A written report carefully documented the synthesis process and differences were resolved by consensus. In the third stage the synthesised version was translated back into English by two bilingual translators whose native tongue was English. These translators had no medical background, were blind to the original version of the SMFA, and were neither aware of nor informed about the concepts explored in the SMFA. With this back-translation process, the validity of the questionnaire is checked to make sure that the translated version is reflecting the same item content as the original version. Unclear wording in the translated version can be discovered in this stage. These two back-translations were reviewed in stage 4 by an expert committee. This committee consisted of the translators, health care professionals, an epidemiologist and a human movement scientist. Equivalence between the original and Dutch versions of the SMFA was reached in four areas<sup>14</sup>: semantic equivalence (ensuring that the words mean the same thing), idiomatic equivalence (ensuring that colloquialisms or idioms are formulated in equivalent expressions), experiential equivalence

(ensuring that each item captures the experience of daily life in the target culture), and conceptual equivalence (ensuring that words hold the same conceptual meaning). Discrepancies were resolved by consensus. This stage resulted in a pre-final Dutch version of the SMFA. This version was tested in a group of 20 patients who had an appointment at the outpatient clinic of the departments of Orthopedics and Traumatology (stage 5). None of the patients reported problems with the items of the Dutch SMFA. Next, the internal consistency, validity, repeatability and responsiveness of the final version of the Dutch SMFA – the SMFA-NL – were assessed.

### Participants

Patients treated for various musculoskeletal injuries or disorders at the departments of Orthopedics and Traumatology, were recruited for this study. Patients with a head trauma, spinal fracture with neurological dysfunction, neuromuscular disease, amputation of a limb, cardiovascular disease with an active episode in the three months previous to the start of this study, cancer, or a serious psychiatric or cognitive disorder were excluded from the study. Patients unable to understand written Dutch were also excluded.

Initially, 260 patients were recruited. Of these patients, a group of 200 patients were (surgically) treated between six months and two years previous to the start of the study. The other 60 patients were (surgically) treated within three months previous to the start of the study. In both patient groups, injuries or disorders located at the upper and lower limbs were equally distributed. All participants were asked to complete three questionnaires at home: the SMFA-NL, the generic questionnaire for health-related quality of life, and a region-specific questionnaire, depending on the region of the injury. A test–retest procedure was used to determine the repeatability of the SMFA-NL. Patients participating in the study part regarding repeatability were asked to fill in the SMFA-NL at home again after three to four weeks. For repeatability, this time interval needs to be sufficiently short to support the assumption that the patients remain stable and sufficiently long to prevent recall. We considered a time interval of three to four weeks to be appropriate. The second patient group was used to determine whether the SMFA-NL is able to detect clinical change over time. This group was asked to fill in the SMFA-NL at home again after two to three months. The flow diagram of the study is presented in Fig. 1.

### Questionnaires

**SMFA.** The 46-item SMFA questionnaire consists of two subscales: the dysfunction index and the bother index. The dysfunction index comprises 25 items for the assessment of patients' perceptions of the amount of difficulty they perceive when performing certain activities of daily living, and nine items for assessing how often they have difficulties performing these activities. The bother index consists of 12 items that allow patients

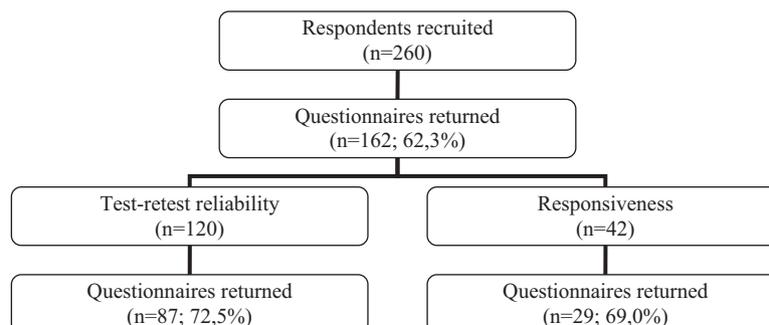


Fig. 1. Flow diagram of inclusion of respondents.

to assess how much they are bothered by problems in various functional areas (e.g., sleep and rest, recreation, work and family). All items are scored on a 5-item Likert scale, ranging from 1 (good function/not bothered) to 5 (poor function/extremely bothered). Scores for the two parts are calculated by summing the responses to the individual items and transforming the scores so that the range is from zero to 100, with higher scores indicating poorer function.<sup>7</sup>

#### Generic health-related quality of life questionnaire

**SF-36.** The 36-item Short Form Health Survey (SF-36) is a generic health status questionnaire that gives an indication of health-related quality of life. The SF-36 is composed of 36 questions, organised into 8 multi-item scales: physical functioning, role limitations due to physical health problems, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems and general mental health.<sup>15</sup> The raw score on each subscale is transferred to a 100-point scale. Since the SMFA-NL uses a transformed score on a 100-point scale where a higher score indicates a poorer function, the 100-point score of the SF-36 was also transformed so that a higher score indicated a poorer function.

#### Region-specific questionnaires

**DASH.** The Disabilities of the Arm, Shoulder, and Hand questionnaire (DASH) is designed to measure patients' ability and perception of their ability to perform different activities and roles and to monitor symptoms associated with any condition in the upper limb. The DASH consists of 30 questions, of which 21 items ask about physical function, 6 items about symptoms, and 3 about social or role function.<sup>4</sup> The items are scored on a 5-point Likert scale. The raw score is transformed into scores ranging from 0 to 100, where a score of 0 indicates minimal disability and 100 maximal disability.

**HOOS.** The Hip disability and Osteoarthritis Outcome Score (HOOS) is developed as an instrument to assess the opinion of patients with hip disability, with or without osteoarthritis, about their hip and related problems. The HOOS consists of 40 items divided into five subscales: pain, other symptoms, function in daily living, function in sports and recreation, and hip-related quality of life.<sup>5</sup> The items are scored on a 5-point Likert scale. For each subscale, the raw score is transformed to a 100-point score. Next, this 100-point score was transformed so that a higher score indicated a poorer function.

**KOOS.** The Knee injury and Osteoarthritis Outcome Score (KOOS) is developed as an instrument to assess patients' opinion about their knee and associated problems. The KOOS consists of 42 items organised into five subscales: pain, other symptoms, function in daily living, function in sports and recreation, and knee-related quality of life.<sup>2</sup> The items are scored on a 5-point Likert scale. For each subscale, the raw score is transformed to a 100-point score. Next, this 100-point score was transformed so that a higher score indicated a poorer function.

**FFI.** The Foot Function Index (FFI) measures the effect of foot problems on function in terms of pain and disability. The FFI consists of 23 items divided into three subscales: limitation, pain and disability. The items are scored on a 5-point Likert scale. For each subscale, the raw score is transformed to a 100-point score; the higher the score, the more limitation/pain/disability is present. The total score on the FFI is the mean of the subscale scores.<sup>3</sup>

#### Statistical analysis

All statistical analyses were performed using PASW statistical package (version 18, SPSS Inc, Chicago). A *p*-value of <0.05 indicated statistical significance.

#### Internal consistency

Internal consistency is a measure of the extent to which items in a questionnaire (sub)scale are homogeneous, thus measuring the same construct.<sup>16,17</sup> The first step in exploring the internal consistency of the SMFA-NL was a factor analysis in order to determine whether the questionnaire actually consists of two subscales. Factor analysis is a technique designed to reveal whether or not the pattern of responses on a number of items can be explained by a smaller number of underlying factors, with each factor reflecting a different construct.<sup>18</sup> Exploratory factor analysis was conducted on all SMFA-NL items using principal component analyses (PCA) with varimax rotation. Factor analyses with a one-, two-, three-, four-, and five-factor solution were performed. Next, Cronbach's alpha was calculated for the identified subscales. It is widely accepted that Cronbach's alpha should be between 0.70 and 0.95.<sup>16</sup> All returned SMFA-NL questionnaires, i.e. those used for assessing validity, repeatability and responsiveness (*n* = 278), were used in this study part.

#### Floor and ceiling effects

The validity, reliability and responsiveness of a questionnaire may be jeopardised if floor or ceiling effects are present. It is then likely that extreme items are missing in the lower or upper ends of the questionnaire. Consequently, respondents with the lowest or highest possible score cannot be distinguished from each other and changes in these patients cannot be measured.<sup>16</sup> Floor and ceiling effects were considered to be present if more than 15% of respondents achieved the lowest or highest possible score.<sup>19</sup>

#### Validity

Because of the absence of a gold standard, validity of the SMFA-NL was expressed in terms of construct validity, which refers to the extent to which scores on a particular measure relate to other measures consistent with theoretically derived hypotheses concerning the constructs that are being measured.<sup>20</sup> Construct validity of the SMFA-NL was determined by comparing the scores of the subscales identified by means of factor analysis and the scores of the conventional subscales of the SMFA with the generic SF-36 and the region-specific questionnaires. To this end, Spearman's Rho correlation coefficients were calculated between the different subscales of the SMFA-NL and the respective subscales of the SF-36 and the other questionnaires. The Spearman's Rho was interpreted according to Domholdt: 0.00–0.25 = little if any correlation, 0.26–0.49 = weak correlation, 0.50–0.69 = moderate correlation, 0.70–0.89 = strong correlation, 0.90–1.00 = very strong correlation.<sup>21</sup>

#### Repeatability

Repeatability concerns the degree to which repeated measurements in stable persons (test–retest) provide the same answers. Repeatability is suggested to consist of two parts: agreement and reliability. Agreement concerns the extent to which the scores on repeated measures are close to each other (absolute measurement error). Reliability concerns the extent to which patients can be distinguished from each other despite measurement errors (relative measurement error).<sup>16</sup>

A measure of absolute agreement is proposed by Bland and Altman.<sup>22</sup> The mean difference between test and retest with a 95% confidence interval (CI) was calculated for absolute agreement. Zero lying within the 95% CI of the mean difference can be seen as a criterion for absolute agreement. Consequently, when zero lies outside the 95% CI a bias in the measurements is indicated. Additionally, the standard error of measurement (SEM), a measure

of the instrument's absolute measurement error, was calculated.<sup>17</sup> The value of the SEM can be derived by dividing the SD of the mean differences between two measurements ( $SD_{diff}$ ) by  $\sqrt{2}$ .<sup>23</sup>

To estimate test–retest reliability of the SMFA-NL subscales, intraclass correlation coefficients (ICCs) with corresponding 95% CIs were calculated. The ICC two-way random effects model, type agreement, was used.<sup>24</sup> ICCs above 0.70 are generally considered to be good.<sup>16</sup>

### Responsiveness

Responsiveness is the ability of a questionnaire to detect clinical change over time. We therefore compared the baseline scores on the SMFA-NL of the respondents who were (surgically) treated in the three months prior to the start of the study to the scores on the SMFA-NL at follow-up. To assess responsiveness, standardised response means (SRM) with corresponding 95% CI were calculated for each subscale of the SMFA-NL. These effect estimates were interpreted according to Cohen: a SRM of 0.2–0.4 was considered a small effect, 0.5–0.7 moderate and 0.8 large.<sup>25</sup>

## Results

### Characteristics of the patients

The demographic characteristics of the respondents are presented in Table 1.

### Internal consistency

Factor analyses were performed with two-, three-, four- and five-factor solutions, and the four-factor solution appeared to be the most interpretable, accounting for 66.4% of the variance (see Appendix 1). The four identified subscales were named *lower-extremity dysfunction* (12 items), *upper-extremity dysfunction* (6 items), *problems with daily activities* (20 items), and *mental and emotional problems* (8 items). The loading factors ranged between 0.47 and 0.85 (see Appendix 1). Cronbach's alpha reliability indices

for the SMFA-NL were 0.94 for the *lower-extremity dysfunction* subscale, 0.93 for the *upper-extremity dysfunction* subscale, 0.97 for the *problems with daily activities* subscale, and 0.87 for the *mental and emotional problems* subscale. Cronbach's alpha was 0.87 and 0.96 respectively for the original *dysfunction index* and *bother index*.

### Floor and ceiling effects

Overall, no floor effects (indicating worst possible score) were found for the subscales of the SMFA-NL or for the conventional subscales of the SMFA. Small-to-moderate ceiling effects (indicating best possible score) were found for the SMFA-NL subscales *lower-extremity dysfunction* (6.3%), *problems with daily activities* (10.0%), and *mental and emotional problems* (13.3%). Large ceiling effects were found for the subscale *upper-extremity dysfunction* (39.8%). Small-to-moderate ceiling effects were found for the conventional subscales of the SMFA: 4.4% for the *dysfunction index* and 14.2% for the *bother index*.

### Validity

The correlations between the SMFA-NL subscales and the subscales of the SF-36, DASH, HOOS, KOOS, and FFI are presented in Table 2.

### Comparison of SMFA-NL with SF-36

The subscale *lower-extremity dysfunction* showed strong correlations with the SF-36 subscales *physical function*. Weak correlations were found between the SF-36 and the subscale *upper-extremity dysfunction*. The subscale *problems with daily activities* showed strong correlations with the subscales *physical function*, *physical role*, and *bodily pain*. Moderate correlations were found between the subscale *mental and emotional problems* and the SF-36 subscales *social function*, *mental health*, *bodily pain*, and *vitality*. The conventional subscales of the SMFA showed strong correlations with the subscales *physical function*, *physical role*, and *bodily pain*, and moderate correlations with the subscales *social function* and *vitality*.

### Comparison of SMFA-NL with DASH

Moderate-to-strong correlations were found between the SMFA-NL subscales *upper-extremity dysfunction* and *problems with daily activities* and the DASH (Table 2). The subscale *mental and emotional problems* showed a strong correlation with the DASH. Moderate and strong correlations were found between the DASH and the conventional subscales *bother index* and *dysfunction index* respectively.

### Comparison of SMFA-NL with HOOS

The subscales *lower-extremity dysfunction*, *problems with daily activities*, and *mental and emotional problems* showed moderate to strong correlations with the HOOS subscale *ADL*. A moderate correlation was found between the subscale *lower-extremity dysfunction* and the HOOS subscale *symptoms*. Low-to-moderate correlations were found between the subscales of the SMFA-NL and the subscales *function in sport and recreation* and *quality of life*. The conventional subscales of the SMFA showed strong correlations with the subscale *ADL*, and the *dysfunction index* showed a moderate correlation with the subscale *symptoms*.

### Comparison of SMFA-NL with KOOS

The subscales *lower-extremity dysfunction* and *problems with daily activities* showed strong correlations, and the subscale *mental*

**Table 1**

Demographic characteristics of the patients who responded to the SMFA-NL questionnaire.

Characteristics	SMFA-NL sample <sup>a</sup> (N = 162)
Age (years) (N = 162)	47 ± 14 (19–74)
Gender	
Male	82 (51)
Female	80 (49)
Marital status (N = 159)	
Single	55 (35)
With partner	65 (41)
With partner and children	33 (21)
With children	6 (4)
Educational level (N = 160)	
Elementary school	4 (3)
High school	70 (44)
College	50 (31)
Bachelor's degree or higher	36 (23)
Location (N = 162)	
Shoulder	24 (15)
Upper arm	6 (4)
Elbow	11 (7)
Underarm	23 (14)
Wrist/hand	18 (11)
Pelvis	6 (4)
Hip/column	26 (16)
Knee	24 (15)
Ankle/foot	24 (15)

<sup>a</sup> All values, except for age, are given as the number of patients, with the percentage in parentheses. Age is given as the mean and standard deviation, with the range in parentheses. SMFA = Short Musculoskeletal Function Assessment.

and emotional problems showed moderate correlations with the KOOS subscales *pain*, *ADL*, and *function in sport and recreation*. Moderate correlations were found between the subscales *lower-extremity dysfunction* and *problems with daily activities* and the KOOS subscale *quality of life*. Moderate-to-weak correlations were found between the SMFA-NL subscales and the KOOS subscale *symptoms*. The conventional SMFA subscales showed strong correlations with the subscales *pain*, *ADL*, and *function in sport and recreation*, and showed moderate correlations with the subscale *quality of life*.

#### Comparison of SMFA-NL with FFI

Strong correlations were found between the SMFA-NL subscales *lower-extremity dysfunction* and *problems with daily activities* and the FFI subscales *difficulty with activities* and *limitations*. The SMFA-NL subscale *problems with daily activities* showed moderate correlations with the FFI subscale *foot pain*. The subscale *mental health* showed only weak correlations with the subscales of the FFI. The conventional SMFA subscale *dysfunction index* showed a strong correlation with the subscales *difficulty with activities* and *limitations* and a moderate correlation with the

subscale *foot pain*. The SMFA subscale *bother index* showed weak correlations with all subscales of the FFI.

#### Repeatability

Table 3 shows the 95% CI of the mean difference between the first and second assessment, SEMs and ICCs of the SMFA-NL subscales. ICCs were high for all subscales, ranging from 0.91 to 0.96. No systematic bias was found between the first and second assessment, as the 95% CI contained zero for all subscales. The SEMs ranged between 8.4 and 11.3. High ICCs were also found for the conventional SMFA subscales (0.94 and 0.95). The subscale *bother index* showed a small systematic bias of two points. The SEMs for the *dysfunction index* and the *bother index* were 7.8 and 10.1 respectively.

#### Responsiveness

Descriptive statistics and responsiveness measures of the SMFA-NL are presented in Table 4. The subscales *lower-extremity dysfunction*, *problems with daily activities*, and *mental and emotional problems* showed small-to-moderate SRMs, ranging from 0.43 to

**Table 2**  
Spearman correlations between SMFA-NL subscales and SF-36, DASH, HOOS, KOOS, and FFI.

	SMFA-NL					
	Lower-extremity dysfunction <sup>a</sup>	Upper-extremity dysfunction <sup>a</sup>	Problems with ADL <sup>a</sup>	Mental and emotional problems <sup>a</sup>	Dysfunction index <sup>b</sup>	Bother index <sup>b</sup>
SF-36						
General health	0.45	0.31	0.53	0.56	0.54	0.56
Physical function	0.81	0.35	0.84	0.56	0.83	0.82
Social function	0.46	0.39	0.61	0.66	0.62	0.66
Physical role	0.56	0.46	0.76	0.56	0.73	0.75
Emotional role	0.26	0.36	0.39	0.49	0.40	0.46
Mental health	0.21	0.31	0.38	0.52	0.38	0.41
Bodily pain	0.64	0.47	0.81	0.68	0.80	0.82
Vitality	0.43	0.36	0.56	0.64	0.56	0.60
DASH						
DASH	n.a.	0.91	0.65	0.74	0.92	0.64
HOOS						
Symptoms	0.60	n.a.	0.50	0.35	0.57	0.43
Pain	0.53	n.a.	0.44	0.37	0.50	0.42
ADL	0.78	n.a.	0.74	0.63	0.79	0.71
Function in sports/recreation	0.51	n.a.	0.44	0.36	0.49	0.41
Quality of life	0.45	n.a.	0.50	0.25	0.46	0.4
KOOS						
Symptoms	0.42	n.a.	0.34	0.52	0.37	0.42
Pain	0.76	n.a.	0.73	0.66	0.79	0.74
ADL	0.86	n.a.	0.85	0.67	0.85	0.86
Function in sports/recreation	0.85	n.a.	0.81	0.66	0.84	0.81
Quality of life	0.60	n.a.	0.55	0.51	0.59	0.57
FFI						
Foot pain	0.55	n.a.	0.49	0.42	0.59	0.45
Difficulty with activities	0.83	n.a.	0.84	0.42	0.81	0.49
Limitations	0.81	n.a.	0.80	0.31	0.83	0.48

KOOS, and FFI.

<sup>a</sup> Newly identified subscales after factor analysis.

<sup>b</sup> Conventional SMFA subscales.

Abbreviations: n.a., not applicable.

**Table 3**  
Descriptive statistics and repeatability measures of the SMFA-NL.

	Baseline mean (SD)	Retest mean (SD)	Mean difference (95% CI)	SEM	ICC (95% CI)
Lower-extremity dysfunction <sup>a</sup>	17.1 (19.5)	17.6 (20.1)	-0.5 (-1.8, 0.9)	8.4	0.96 (0.93, 0.97)
Upper-extremity dysfunction <sup>a</sup>	13.6 (22.6)	13.1 (21.4)	0.5 (-1.0, 1.9)	9.5	0.95 (0.93, 0.97)
Problems ADL <sup>a</sup>	27.7 (21.7)	26.3 (22.5)	1.3 (-0.4, 3.0)	11.0	0.94 (0.90, 0.96)
Mental and emotional problems <sup>a</sup>	23.7 (18.7)	23.2 (18.8)	0.5 (-1.2, 2.2)	11.3	0.91 (0.87, 0.94)
Dysfunction index <sup>b</sup>	20.9 (16.9)	20.7 (17.6)	0.2 (-1.0, 1.5)	7.8	0.95 (0.92, 0.97)
Bother index <sup>b</sup>	25.7 (20.7)	23.7 (21.0)	2.0 (0.5, 3.5)	10.1	0.94 (0.90, 0.96)

<sup>a</sup> Newly identified subscales after factor analysis.

<sup>b</sup> Conventional SMFA subscales.

**Table 4**  
Descriptive statistics and responsiveness measures of the SMFA-NL.

	N	Baseline mean (SD)	2nd assessment mean (SD)	Mean difference (SD)	SRM
Lower-extremity dysfunction <sup>a</sup>	12	29.8 (20.6)	24.5 (19.0)	5.3 (12.3)	0.43
Upper-extremity dysfunction <sup>a</sup>	17	36.2 (21.4)	31.9 (21.6)	4.3 (16.4)	0.26
Problems ADL <sup>a</sup>	29	38.7 (30.1)	32.1 (25.8)	6.6 (15.1)	0.44
Mental and emotional problems <sup>a</sup>	29	22.5 (22.8)	14.7 (18.0)	7.8 (16.7)	0.47
Dysfunction index <sup>b</sup>	29	40.5 (23.6)	35.4 (23.8)	5.1 (19.2)	0.27
Bother index <sup>b</sup>	29	30.2 (20.0)	27.7 (20.5)	2.5 (14.7)	0.17

<sup>a</sup> Newly identified subscales after factor analysis.

<sup>b</sup> Conventional SMFA subscales.

0.47. The subscale *upper-extremity dysfunction* showed a small SRM of 0.26. Both subscales of the conventional SMFA showed small SRMs (0.27 and 0.17) (Table 4).

## Discussion

Cross-cultural adaptation of a health status self-reported questionnaire for use in a country other than where it was developed is necessary to maintain the content validity of the instrument at a conceptual level across different cultures.<sup>9,14</sup> Clinimetric quality of the translated questionnaire should be investigated after translation.<sup>26</sup> Both the conventional subscales of the SMFA and the by-factor analysis identified subscales of the Dutch version of the Short Musculoskeletal Function Assessment questionnaire (SMFA-NL) demonstrated sufficient internal consistency, validity, repeatability and responsiveness. Hence this study shows that the SMFA-NL is a valid, reliable and responsive method for the assessment of functional status of patients who have a broad range of musculoskeletal disorders.

The original SMFA questionnaire contains two parts: the *dysfunction index* and the *bother index*.<sup>7</sup> The internal consistency coefficients for the conventional subscales of the SMFA were high: Cronbach's alpha of 0.87 and 0.96 respectively for the *dysfunction index* and the *bother index*. These results are comparable with those found by Swiontkowski et al.<sup>7</sup> in the initial validation of the SMFA, and with those found in the validation of the Brazilian,<sup>13</sup> Mexican,<sup>12</sup> Swedish<sup>10</sup> and German<sup>11,27</sup> version of the SMFA. We performed a factor analysis to determine whether the SMFA-NL also consisted of two parts, but identified a four-factor structure: (1) lower-extremity dysfunction, (2) upper-extremity dysfunction, (3) problems with daily activities, and (4) mental and emotional problems. Internal consistency of these subscales was proven. Only Guevara et al.<sup>12</sup> and Taylor et al.<sup>13</sup> who assessed the validity of the Mexican and Brazilian versions of the SMFA respectively, have performed a factor analysis. They both found a three-factor solution to be the most interpretable.<sup>12,13</sup> However, five items of the Mexican version failed to load on one of the three factors, so the authors recommended that these items of the questionnaire be dropped.<sup>12</sup> Eight items of the Brazilian version of the SMFA did not clearly load into this three-factor solution, and these items were also dropped.<sup>13</sup> By dropping these items, both the Mexican and Brazilian versions of the SMFA can no longer be compared with the original version or with versions in other languages which contain all items. In the present study, all items loaded on one of the four identified subscales.

Overall, no floor effects indicating a worst possible score, were found for the subscales of the SMFA-NL and the original SMFA. However, some ceiling effects, indicating a best possible score, were found for both the SMFA-NL and the original SMFA. Floor and ceiling effects were also assessed in the initial validation of the SMFA.<sup>7</sup> They found no floor effects either, but small ceiling effects. This difference in the amount of ceiling effects might be due to a difference in patient population. For the initial validation of the SMFA, 50% of the included patients had an acute fracture or soft-tissue injury of an extremity. In our study, 120 (74%) of the 162

included patients were treated for their musculoskeletal injury or disorder at least six months before participation in this study. Hence a large proportion of these respondents might no longer experience limitations in physical functioning. As a result, large ceiling effects were found for the subscale *upper-extremity dysfunction* of the SMFA-NL. Moreover, of all musculoskeletal impairments, impairments of the upper extremity are associated with the least disability.<sup>28</sup> One must therefore bear in mind that patients with injuries to the upper extremities are likely to report less limitations in physical functioning.

Construct validity of the SMFA-NL was determined by comparing the scores of the subscales identified by means of factor analysis and the scores of the conventional subscales of the SMFA with the generic SF-36 and region-specific questionnaires. Moderate-to-strong correlations were found between the subscales of the SMFA-NL and the respective subscales of the SF-36. However, weak correlations were found between the subscale *upper-extremity dysfunction* and the subscales of the SF-36. The Brazilian and Mexican versions of the SMFA contain an upper-extremity dysfunction subscale.<sup>12,13</sup> The correlations between this subscale and the subscales of the SF-36 were weak too. These results can be explained by the fact that the SF-36 contains mostly items on physical dysfunction of the lower extremity. Therefore, the SF-36 might be less suitable to assess limitations in physical functioning of patients with injuries to the upper extremities. Moderate-to-strong correlations were found in this study between the conventional subscales of the SMFA and the respective subscales of the SF-36. Overall, the correlations between these conventional subscales and the SF-36 were comparable to the findings of Swiontkowski et al.<sup>7</sup> regarding validation of the original SMFA and to the findings of several translated versions of the SMFA.<sup>11–13,27,29</sup>

To our knowledge, this is the first study in which the validity of the SMFA is determined by means of several region-specific self-reported questionnaires. In this study the construct validity of the SMFA-NL to assess functional status of patients with musculoskeletal injuries or disorders of upper extremity was proven. Moderate-to-strong correlations were found between the SMFA-NL subscales and the DASH, and strong correlations were found between the conventional subscales of the SMFA and the DASH. Overall, the SMFA-NL subscales and the conventional SMFA subscales showed moderate-to-strong correlations with the respective subscales of the HOOS and KOOS, indicating good construct validity of the SMFA-NL to assess functional status of patients with musculoskeletal injuries or disorders of the hip and knee. Low correlations were found between the subscale *lower-extremity dysfunction* of the SMFA-NL and the KOOS subscale *symptoms*. Since the items of the *symptoms* subscale consists of very specific questions about knee symptoms, such as swelling, grinding, and clicking noises during movement, a low correlation was expected. Low correlations were found between the SMFA-NL subscale *lower-extremity dysfunction* and the HOOS subscale *function in sports and recreation*, whilst this subscale of the KOOS showed a strong correlation. This discrepancy can be caused by differences in patient population. A large proportion of the patient group with knee problems consisted of individuals with meniscal

repairs and knee arthroplasties, who tend to be relatively young and physically active. The group of patients with hip problems consisted largely of persons who had undergone a total hip arthroplasty or sustained a proximal femoral fracture; such patients are generally older and less physically active, and the questions about sport and recreation are less relevant for them. The SMFA-NL subscales and the conventional SMFA subscales demonstrated moderate-to-strong correlations with the respective subscales of the FFI. Hence the SMFA-NL showed good construct validity to assess functional status in patients with foot problems.

In general, the results of this study showed that the SMFA-NL subscales *lower-extremity dysfunction*, *upper-extremity dysfunction* and *problems with ADL* correlated well with the respective subscales of the SF-36 and the region-specific self-reported questionnaires, indicating good construct validity. The SMFA-NL subscale *mental and emotional problems* showed weak to moderate correlations with the other questionnaires, since there was little similarity of content between these subscales.

A test–retest procedure was used to determine the repeatability of the SMFA-NL. Repeatability of the SMFA-NL subscales was high, with no systematic bias between the first and second assessment. Repeatability of the conventional subscales was also high, with a small systematic bias of two points in the subscale *bother index*. Overall, the intraclass correlation coefficients of the conventional subscales were comparable to the findings of Swiontkowski et al.<sup>7</sup> regarding repeatability of the original SMFA and to the findings of several translated versions of the SMFA.<sup>10,12,13</sup> Interpretation of the SEM, i.e. whether it should be interpreted as a large or a small measurement error, depends on what changes are minimally important on the SMFA. Knowledge of the amount of measurement error adds to the clinical relevance when outcome measurements are used for evaluative purposes, such as evaluating effect of surgery.<sup>17</sup> However, the minimally important changes on the SMFA have not been established yet.

Before determining the amount of change in score of the SMFA over time that is clinically important, the responsiveness of the SMFA, i.e. whether the SMFA is able to detect changes over time, should be assessed. Responsiveness of the SMFA-NL was moderate, as small to moderate standardised response means (SRMs) were found for the subscales *lower-extremity dysfunction*, *problems with daily activities*, and *mental and emotional problems* of the SMFA-NL. The subscale *upper-extremity dysfunction* showed a small SRM. The SRMs for the conventional subscales were also small. The size of the SRMs found in this study are lower compared to previous research into the responsiveness of the SMFA. Swiontkowski et al.<sup>7</sup> found moderate-to-large SRMs and Ponzer et al.<sup>10</sup> found large SRMs. These studies also used a time interval of approximately three months between the first and second test sessions. Contrastingly, Swiontkowski et al.<sup>7</sup> reported SRMs per subgroups created based on the question: “How is your health now compared to when you completed this survey before: worse/the same/better?”, and the study group of Ponzer et al.<sup>10</sup> consisted only of patients with an acute fracture of the distal radius or ankle. In this study, the patient group consisted of patients who were (surgically) treated within the three months preceding the start of the study. They filled in the SMFA-NL for the second time two to three months after the first time. The lower SRMs found in this study might therefore be caused by the fact that some patients were already recovered at the first assessment of the SMFA-NL, consequently failing to show any improvement at the second assessment. The fact that the mean differences were small but their standard deviations large underline this notion. However, the responsiveness of the original SMFA has been proven<sup>7</sup> and the responsiveness of the Swedish version<sup>10</sup> was comparable to the original SMFA. Furthermore, in this study with a small and relatively heterogeneous population already moderate SRMs were

found, one can argue that in a larger and more homogeneous population of patients with acute musculoskeletal injuries the responsiveness of the SMFA-NL would be proven. Furthermore, the SRMs of the subscales of the SMFA-NL were larger compared to those of the conventional subscales of the SMFA, which indicates that the newly identified subscales of the SMFA-NL are more sensitive to change in functional status.

## Conclusion

We successfully translated and culturally adapted a Dutch version of the Short Musculoskeletal Function Assessment questionnaire (SFMA-NL). Both the conventional subscales of the SMFA and the by-factor analysis identified four subscales of the SMFA-NL demonstrated good internal consistency, validity, repeatability and moderate responsiveness. Hence this study shows that the SMFA-NL is a valid, reliable and moderately responsive method for the assessment of functional status of patients who have a broad range of musculoskeletal disorders.

## Conflict of interest

None to declare.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.injury.2011.07.013.

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