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How to translate and locally adapt a PROM. Assessment of cross-cultural differential item functioning.

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Running head: Translation and local adaption of PROMs

Abstract:

Translating patient reported outcome measures (PROMs) can alter the meaning of items and undermine the PROM's psychometric properties (quantified as cross-cultural differential item functioning (DIF)). The aim of this paper was to present the theoretical background for PROM translation, adaptation, and cross-cultural validation, and assess how PROMs used in sports medicine research have been translated and adapted. We also assessed DIF for the Knee Injury and Osteoarthritis Outcome Score (KOOS) across Danish, Norwegian, and Swedish versions.

We conducted a search in PubMed and SCOPUS to identify the method of translation, adaptation, and validation of PROMs relevant to musculoskeletal research. Additionally, 150 preoperative KOOS questionnaires were obtained from the Scandinavian knee ligament reconstruction registries, and cross-cultural DIF was evaluated using confirmatory factor analysis and Rasch analysis.

There were 392 studies identified, describing the translation of 61 PROMs. Ninety-four percent were performed with forward-backwards technique. Forty-nine percent used cognitive interviews to ensure appropriate wording, understandability, and adaptation to the target culture. Only two percent were validated according to modern test theory. No study assessed cross-cultural DIF.
One KOOS subscale showed no cross-cultural DIF, two had DIF with respect to some (but not all) items, and thus conversion tables could be constructed, and two KOOS subscales could not be pooled.

Most PROM translations are of undocumented quality, despite the common conclusion that they are valid and reliable. Scores from three of five KOOS subscales can be pooled across the Danish, Norwegian, and Swedish versions, but two of these must be adjusted for DIF.

Key words: PROMs; translation; Cultural adaption; construct validity; Differential item functioning; Cognitive interview; data pooling; Knee Ligament Reconstruction Registry.

Case:

Three strategies (debridement, microfracture and no treatment) to handle full-thickness lesions of knee hyaline cartilage were evaluated by identifying patients with a knee ligament reconstruction and a cartilage lesion in the Norwegian and Swedish National Knee Ligament Registries. The outcome two years after surgery was the Knee Injury and Osteoarthritis Outcome Score (KOOS). Linear regression analyses were used to evaluate the effect of debridement and microfracture on the domain scores of KOOS[1].

No significant effects of debridement were found on any of the KOOS subscales at two-year follow-up compared to no treatment. Microfracture treatment was associated to significantly worse scores compared to no treatment at two-year follow-up in the KOOS Sport and Recreation and Knee-Related Quality of Life subscales. For the remaining KOOS subscales of Pain, Symptoms and Activities of Daily Living, there were no significant effects of microfracture.

It was concluded that microfracture of concomitant full-thickness cartilage lesions showed adverse effects on patient-reported outcomes at two-year follow-up after ACL reconstruction. Debridement of concomitant full-thickness cartilage lesions showed neither positive nor negative effects on patient-reported outcomes at two-year follow-up after ACL reconstruction[1].

Comment: The psychometric properties of the Norwegian and Swedish versions of KOOS have not been compared in a joint data set with individuals from both countries, so it is not known, if data from the two cohorts can be directly pooled. Whether KOOS functions differently across countries can be tested in a pooled dataset. If items or scales function differently between countries, this can often be adjusted for by using conversion tables derived from pooled data sets.

Introduction.

A common reason for translating and adapting patient related outcome measures (PROMs) from one language to another is that a specific PROM is needed for a study but does not exist in the local language. If a PROM has been developed with help from relevant patient groups, using valid methods, so it has content relevance and coverage for the patients in the planned study, then this is a good reason to translate and adapt the existing PROM instead of developing a new one. This is easier and less time consuming.

In other cases, there is a desire to conduct studies across countries, languages, or cultures, for instance in multi-centre trials involving different countries or trials in countries where there is more than one national language. Also, international clinical databases need the same outcome measures in all the participating countries, so data can be pooled or compared, and this includes relevant PROMs. There is an increasing need in relation to planning and financing in health policy to be able to compare clinical outcomes from different countries or cultural groups. PROMs are important in this context, which emphasizes that measurement must be independent of language and culture.

To adapt a PROM to a new language or culture is not trivial. Even for languages that are spoken by many people globally across different countries, such as Spanish, English and Arabic, the same basic language can have quite varied versions, as the habits and cultures of the different countries can diverge substantially. The same word or expression can carry different connotation and meaning across the different countries, or objects can be described by different words in the same language, dependent on culture or geography. For example, “braces” in the United Kingdom (UK) are called “suspenders” in the United States (US), where “braces” are used to straighten teeth.

Also, life conditions can be very different within language areas, dependent on socioeconomic, religious and cultural conditions and are often very different between countries. Therefore, the content of the items in a PROM may not have the same meaning or importance when it is translated to a new culture.

All these issues create methodological challenges when a PROM is translated and adapted to a new language and culture.

There are several ways to conduct translation and adaption, and there is evidence that a rigorous and multistep procedure leads to a better translation and adaption[2].

Once a PROM has been translated and adapted it should be confirmed that it measures in the same way (invariantly) for all persons. Even within the same language and culture items can function differently dependent on for instance gender or age, and this is called differential item functioning (DIF)[3,4]. This is probably even more pronounced between

countries and cultures (cross-cultural DIF), for instance do Norwegians understand and respond to items in the same way as Americans? If results are compared between cultures or countries, or if data from several countries are pooled, items that have cross-cultural DIF introduce a systematic bias that will give respondents in different countries a different score, even though their condition is the same. For example, it was demonstrated by comparing results from the three Scandinavian knee ligament reconstruction registries that Danish patients have significantly lower scores in the KOOS domain "Symptoms" compared to their Norwegian and Swedish counterparts, both preoperatively and postoperatively[5]. Therefore, cross-cultural DIF can be suspected for items in this domain.

The presence of cross-cultural DIF is of course most important if data from different countries or cultures are pooled into one dataset. This is typically done in international databases or when national clinical databases are pooled, but also randomized multicentre studies and studies including cohorts in different countries can be affected by cross-cultural DIF, like the Delaware-Oslo cohort of ACL patients[6,7].

The theoretical background

In most cases, PROMs are developed in one language and culture and then translated and adapted to other languages and settings. The most commonly used PROMs in sports science were all developed within the Western culture[8]. The main and most important objective of the translation and adaptation process of a PROM across settings is to transfer the meaning of each item and construct encompassed in the PROM from the original language and culture into another language and culture. This involves transfer of the wording as well as the relevance of each item.

There are four criteria, which must be considered for the translated PROM, as defined by Beaton[9]:

1. Semantic equivalence, meaning grammatical and vocabulary equivalence with the original PROM. Ambiguous wordings are avoided (i.e., the translated words must have one meaning and be understandable to everyone).
2. Idiomatic equivalence. Some expressions are idioms, meaning that the words themselves give no understanding of the expression. An example is "feeling downhearted and blue" (from Short Form 36 (SF-36)). Idioms must be reworked beyond translation, but for some idioms, there is no equivalent expression in target languages.
3. Experiential equivalence, meaning that some activities are not the same in the local setting and must be replaced by something equivalent. An example is that

skiing was replaced by surfing in the translation of a PROM from American English to Brazilian Portuguese[10].

4. Conceptual equivalence, meaning that specific concepts (for instance "family", "work", and "leisure time") may have very different meanings in different cultures, which can result in different answers.

It is generally recommended that questionnaires can be understood by the equivalent of a 12-year-old (Grade 6 reading level)[9], but the importance of this is of course dependent on the target population and its educational level. This can be a problem in countries, where a larger proportion of inhabitants do not have an educational level past Grade 6.

Translation and cultural adaption

The first part of the process to translate a PROM into a local language is of course to translate the wording of the items and the instruction. The two most accepted methods are somewhat different: forward-backward translation and dual-panel translation. The steps are described in box 1 and 2 in the supplementary materials.

Of the two methods, the most frequently used is *forward-backward translation*, described in detail by Beaton[9]. With this method, the translation is sometimes performed by linguistic experts (e.g., professional translators) or healthcare professionals, and thus, there is a risk that the wording will not be in common lay language and thereby has suboptimal meaning or readability for the majority of the general population. This can only be addressed by conducting some kind of cognitive interviewing or field test of the understandability of the wording after the forward-backward translation has been conducted to ensure that meaning is not lost and that the translated version of the PROM is understandable for lay people[9]. As PROMs in most cases are completed by laypersons who are patients, cognitive interviewing regarding the wording should primarily be performed with laypersons. Healthcare professionals tend to use professional phrases, and patients tend to focus more on their disease(s) and thereby the subject matter in the PROM than on the actual language, meaning, and understandability, and neither of these groups are optimal for cognitive testing of the wording (the language).

However, patients with the condition that the PROM is meant to cover can participate in cognitive testing of the understandability of the translated PROM – does the wording make sense for the subjective understanding of the condition? This can be necessary, as a translation by professional translators can be linguistically correct, but not meaningful for the target group. This means that after the forward-backward translation has been carried

out, the PROM needs to be field-tested through cognitive interviews for understandability, and, if necessary, modified.

Conversely, the main purpose of the *dual-panel translation and adaptation* method is to ensure the quality of the translation during the translation process itself[11] (box 2). The primary translation is made in a group of bilingual persons and the wording is discussed (and possibly modified) until the group agrees that meaning of the wording in the original version is covered in the translated version. The second panel includes a lay panel of 3-5 local persons, who in plenum can discuss the wording and modify the items that have been proposed by the first bi-lingual panel. So, if the dual-panel method is used, it is not necessary additionally to test the translated version for wording or understandability, as this is already part of the method.

Preferably, the researcher involved in developing the original PROM can be part of the entire translation and adaptation process and help ensure that the meaning of the items and constructs are kept in the translation process across the settings[11].

Assessing the psychometric properties of the translated PROM

Regardless of which translation and adaptation method is used, an equally important aspect is to conduct psychometric analyses to confirm the construct validity of the PROM scales in the new setting and ideally whether there is DIF across the settings (i.e., across the two versions)[4]. Does the PROM measure the same single construct, or multiple constructs, in both settings, and do people in both settings interpret the items in the same way? Language DIF is in particular important to consider when comparing data and results from different countries, for instance in relation to publications of combined data from several countries (e.g., from National clinical databases such as knee-ligament reconstruction registries, arthroplasty registries, etc.). However, when psychometric properties are tested, it is usually only performed on data collected from one country, and thus cross-cultural analyses of the psychometric properties between the original and the translated measure are not addressed[4]. This is suboptimal if results are compared between countries. When PROM data is analysed in pooled data sets with data from more than one country, simple adjusting for the effect of country in a regression model is not sufficient. Consider the following analogy: A multi-centre study measures the primary outcome as changes in temperature. Some centres use Celsius while others use Fahrenheit. Adding an effect of country in your regression model will not yield a correct analysis. However, knowing how to translate from one temperature scale to the other will enable you to do a valid analysis. Therefore, conversion tables are required.

The optimal procedure of cross-cultural analysis is to evaluate validity in each language version separately and subsequently pool collected data and assess measurement

invariance and DIF relative to language for each domain score in the pooled data set. In this way, it is possible to reveal if persons with the same overall score on the remaining items systematically give different responses to the item being tested. If the difference in mean item scores for an item with DIF for the pooled scores (i.e., the combined data) is uniform along the scale (as measured by the total score), then this difference can be adjusted across the settings, so long as fit to a measurement model is maintained[3]. If this is the case, the item displays DIF across country, language, and culture. Once DIF has been identified, it can be compensated for using conversion tables, when data are reported. Measurement invariance can be tested using multiple groups confirmatory factor analysis (CFA)[12], while DIF is most easily tested using item response theory (IRT). DIF can best be explained using the item location. For example, in a scale that measures the impact of knee function on quality of life, an item that assesses whether the respondent is able to go cross-country skiing would have a different location (i.e., level of difficulty on the scale) for Swedes and Norwegians (who have a long tradition for skiing regularly) compared to Danes (who mainly go skiing during vacations). It would be expected that a small proportion of Danish respondents, but a larger proportion of Swedes and Norwegians, would report this to have an impact on health-related quality of life. Since the ordering of all items in terms of level of difficulty included in a scale can be determined using IRT models, this provides a way to test items in scales for DIF in relation to country, language, and culture[3]. Such analyses for unidimensionality and DIF can provide robust evidence that the same constructs are actually measured in the same way across different borders, and that this is done invariantly[3]. Results of PROM scores that are pooled from several countries can be different, dependent on whether DIF has been compensated for or not.

Hypotheses and aims

It is stated in most articles reporting translation and adaption of a PROM that it was found to be a valid and reliable measurement tool in the translated version. However, it is not known to which extent translation, adaptation, and validation of versions in languages other than the original PROMs in sports in fact has been performed optimally. It was hypothesized that for a majority of PROMs used in sports research optimal methods had not been employed in the adaptation and validation of translated versions. Furthermore, it was hypothesized that calculation of local DIF and cross-cultural DIF was generally not performed.

In relation to the Scandinavian knee ligament reconstruction registries, it can be relevant to pool data from the three countries (Norway, Sweden, and Denmark). However, it has never been assessed whether there is cross-cultural DIF for the main outcome, KOOS. It

was hypothesized that there may be cross-cultural DIF between the local Scandinavian versions of KOOS, and that this can be compensated for, when pooled data are reported.

The aims were therefore twofold:

1. To study how translation, adaptation and validation was performed in the local versions of the most commonly used and relevant PROMs in Sports. These comprised 61 PROMs which had been identified from searches in PubMed 2011-20, being either commonly used (more than three times during this time period), used in randomized studies on musculoskeletal conditions or being the only PROM for a specific musculoskeletal condition of relevance. Translated versions of these 61 PROMs were searched for in PubMed and SCOPUS. This is described in detail elsewhere[8].

2. To assess cross-cultural DIF in the questionnaire KOOS between Denmark, Sweden, and Norway.

Methods.

Aim 1:

All published translated versions of the 61 PROMs that were identified in[8] were analyzed.

The quality indicators for translation and adaptation of a PROM for use in another country, language, or culture were defined by three components:

1. *Translation and adaptation:* Has the meaning of the items and constructs in the PROM been adequately transferred from the original language and culture to the other language and culture?

2. *Validation of the construct of the translated scale:* Has a test of unidimensionality and DIF of the scale(s), optimally using IRT models, been conducted?

3. *Functioning of the translated PROM compared to the original version:* Has a test of item ordering in scale(s), using IRT models, been conducted, both separately for the countries and with the data from the different countries combined (i.e., are the ordering and locations consistent across countries)? Has a cross-cultural DIF analysis been conducted with data from the different countries combined?

Validation of the construct(s) was not included in the analyses for this study, as this has been assessed elsewhere[8]. Also, assessment of development of the original version has been covered in[8].

Details of the analyses are supplied in the supplementary materials ("Details of recorded information").

Aim 2:

To assess cross-cultural DIF for KOOS in Denmark, Norway, and Sweden, data from questionnaires completed preoperatively were obtained from National knee ligament reconstruction registries in each country. From each registry responses from 75 women and 75 men, aged 18-37 years, between 2016 and 2018 where included. Validity was evaluated using CFA and Rasch models and the hypothesis of measurement invariance, that the latent variables are understood and measured in the same way across countries[13], and absence of cross-cultural DIF was tested using multiple groups CFA by the latest available guidelines[14] and graphical Rasch models[15]. The R package lavaan[16] and the software package DIGRAM[17] were used.

For all subscales the following analyses were considered: First, validity in each country was assessed using CFA and Rasch analysis, controlling the type I error rate using the false discovery rate[18]. Second, the fit of a multiple groups CFA models with configural invariance and of graphical Rasch models were evaluated.

For subscales where these basic validity requirements were met multiple groups CFA models and graphical Rasch models with invariance were fitted. Sub scales where these restricted models fitted were categorized as having measurement invariance and no DIF. For subscales where this was not the case models with partial invariance were applied to identify items with DIF. Model fit is evaluated using chi-square test for CFA models and Andersens conditional likelihood ratio test for Rasch models[19].

For subscales where models with partial invariance could be fitted to the data conversion tables are reported.

Results:

Aim 1 (table 1-9 in the supplementary materials):

Translation:

Of the analyzed 392 PROM studies, direct translation by the researcher, with no formal procedure to secure quality, had been performed in 16. In 368 PROM studies (94%) the forward-backward method was used, and one study used the dual-panel method (tables 1-9). In 6 cases the method of translation had not been described.

Language adaption

Among the 391 PROMs that had not been translated by the dual-panel method, wording had been discussed through individual interviews in 192 (49%) (tables 1-9 in the supplementary materials). In 120 cases (31%) the understandability was tested by analyses of filled out questionnaires but without interviews. In 61 the wording had not been discussed and in 16 it was not described if wording had been discussed.

Content adaption

In 291 (74%) of the translated PROMs, patients had been involved in testing relevance and understandability, while this was not the case in 80 and not described in 19 cases (tables 1-9). In 194 cases (49%) the pre-version of the PROM had been modified after testing, while no changes had been applied in 168 cases.

Unidimensionality

In 11 cases (3%), unidimensionality had been assessed for the translated version, in no cases for the original and the translated versions individually, and in no cases for the pooled data set (tables 1-9 in the supplementary materials).

Cross-cultural DIF

DIF had not been assessed for the local PROM in any case. Cross-cultural DIF had been assessed in one case (for The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)) but not in relation to translation (tables 1-9 in the supplementary materials).

Aim 2:

Fit indices for models where no items were restricted to be equal across countries (sometimes called 'configural invariance' models) showed poor fit for all subscales except Quality of Life (QoL) (results not shown). Adjustment for multiple testing (five subscales in three countries using two different methods yielding 30 statistical tests) was used. Additional analyses using models with correlated error terms/local response dependence showed adequate fit for all subscales except Activities of Daily Living (ADL). No model with correlated error terms/local response dependence fitted this subscale.

Since there is no point in evaluating cross-cultural validity when there is no evidence of validity in any of the three countries, the question of cross-cultural validity was addressed for the four other subscales only. Fit indices for multiple group analyses for these are reported in Table 11. For the ADL subscale, that did not meet validity requirements in any of the countries. evaluation of cross-cultural validity was meaningless.

Fit indices for models where no items were restricted to be equal across countries (sometimes called 'configural invariance' models) showed adequate fit for the QoL subscale only (results not shown). Including local dependence (correlated error terms) yielded models with adequate fit (results not shown).

Fit indices for models where all items were restricted to be equal across countries (sometimes called 'scalar invariance' models) showed adequate fit for the QoL subscale only (results not shown). For the three subscales Pain, Symptoms and Sport we used multiple groups CFA and graphical Rasch models in an attempt to identify models where some, but not all items were restricted to be equal across countries (sometimes called 'partial invariance' models). The items, that are not restricted, are the items that have cross-country DIF. For the Pain subscale the items P2 and P7 showed DIF, for the Symptoms subscale all items showed DIF, and for the Sport subscale the item Sp4 showed DIF (Table 10). This means that for the Pain subscale and the Sport subscale conversion tables can be constructed (Table 11).

In summary, the assessment of cross-cultural DIF across Denmark, Norway and Sweden for the KOOS subscales yielded different results for the five subscales. The ADL subscale did not show construct validity in any of the three countries, making evaluation of cross-cultural validity meaningless. The Symptoms subscale was valid in all countries, but all items displayed evidence of DIF. As no items are on the same metric for this domain, translation from the metric of one country to the metric of another country is not possible. The Pain and Sport subscales were valid in all countries, but they had DIF with respect to some (but not all) items. As the items in these two domains without DIF are on the same metric, translation from the metric of one country to the metric of another country can be based on these, and conversion tables could be constructed. The QoL subscale was valid in all countries with no evidence of DIF, and therefore scores from this sub-scale for the different countries can be pooled with no conversion.

The conversion table (Table 11) can be used to translate KOOS scores of the Pain and Sport sub-scales from one country to the metric of the corresponding KOOS sub-scales score in the other two of the three Scandinavian countries. For example, a Danish patient scoring (2,3,3,1,2) on the five items in the Sport sub-scale have a score of 50 for the sub-scale (the mean item score is divided by four and the result is transformed linearly to a zero to 100

scale, 100 indicating no problems and 0 indicates extreme problems, according to the instructions for KOOS). If the score from this patient is compared to or pooled with scores from Norwegians or Swedes, the score must be translated to 48.2 and 48.3, respectively. In a pooled dataset from all the three Scandinavian countries, one country is chosen as reference, and scores from the two other countries are transformed according to table 11 before they are pooled.

Discussion:

Aim 1:

This study showed that almost all of PROMs had been translated by the forward-backward method based on the instructions described by Beaton et al. in 2000[9], to which almost all authors referred. About half of the translations had followed the instructions regarding translation and cultural adaption in detail, which is better than hypothesized. However, for the vast majority construct validity had not been assessed by the most adequate methods (modern test theory models), which reduces confidence in the measurement properties.

This shows that the conclusion in most of the 392 manuscripts: "The translated PROM is a valid and reliable measurement tool" would not necessarily be correct, if thorough translation, adaptation and validation had actually been performed by optimal methods. The better methods, the higher risk there is to find that the PROM is not reliable and valid. Therefore, instead of referring to the conclusion in the translation-manuscript when the choice of PROM for a study is argued for, authors should describe the methods that had been used for translation, adaption and validation and search literature for additional assessments. There are several examples of translations, which have been assessed as reliable and valid using classical test theory methods only, that have been shown not to be valid when tested using modern test theory– and this should of course be accounted for in the study article.

A surprising but potentially serious problem that this study has identified is that for several PROMs that had been developed in patient populations with a mother tongue which was not English, an English version of the questionnaire was published with the development article, but with no documentation that it had been translated through any controlled process or been adapted in an English speaking country. As these English versions have been basis for the majority of other translations of these PROMs, the validity of the translated versions can, in principle, be questioned. This is the case for the Copenhagen Hip and Groin Outcome Score (HAGOS), the Foot and Ankle Outcome Score

(FAOS) and The Achilles Tendon Total Rupture Score. The 5 domains in KOOS and the Hip dysfunction and Osteoarthritis Outcome Score (HOOS) consist of 3 domains from the WOMAC, which were developed in a community of Canadian-English speaking patients, and 2 domains that were developed in a Swedish speaking population, but there is no documentation that WOMAC had been thoroughly translated to Swedish or the two other domains had been thoroughly translated into English. KOOS and HOOS were originally validated in a community of Swedish speaking patients. This means, that there is no documented validity of the English versions of KOOS and HOOS, and the Swedish version is questionable, as the process of translation to Swedish of 3 of 5 domains has not been documented. KOOS-Child was developed in a Swedish speaking community, and there is no documentation that the English version is based on a thorough translational and cultural adaptation process. The Achilles Tendon Total Rupture Score was also developed in Swedish, but how translation into the English version that was published in the development article had been performed, is not documented. Nine of the 12 translations of this PROM have been made from the English version. The Forgotten Joint Score was developed and validated in a German speaking community, but the English version (from which 5 of 7 translations have been made) has not been documented. The Kujala Score (Anterior Knee Pain Scale) was developed in a Finnish setting, but there is no documentation of the translation to English (from which 9 of 10 translations were made). The Lysholm score was developed in Swedish and it is not documented how it was translated into English (from which 4 of 6 published translations were made).

In addition to the translations that were identified for this study through academic search strings, there is a large number of translated versions, which have either not been documented or have only been published in grey literature. As an example there are 51 versions of KOOS, 14 versions of HAGOS, 25 versions of HOOS, 17 of FAOS and 7 versions of KOOS-Child available (as of January 1, 2020) from www.koos.nu, whereas the respective numbers of identified, published translations are 19, 4, 13, 11 and 2. This shows, that it is essential that reports on translation and adaption are actually peer reviewed and published.

It is rare that a PROM is developed simultaneously in different languages and settings. This has been described for KOOS, KOOS-Child and the Functional Assessment Scale for Acute Hamstring Injuries (FASH). The latter was developed in a Greek community and translated into German and French by the forward-backward method[20]. Even though the process is not described in all details, this has resulted in three valid PROMs. However, it is not a simultaneous development as only Greek patients participated in the development of items. KOOS is a mixture of subscales, that were developed in Canada (3 domains) and in Sweden (2 domains) but not simultaneously. So, there are no examples related to musculoskeletal conditions of PROMs developed simultaneously in difference countries or

cultures. This would be an optimal method to develop PROMs for patients with rare diseases, for instance children with ACL-rupture, as it is difficult to involve enough patients for development in one country.

A very thorough guide to forward-backward translation and cultural adaption is available in Wild D et al[21].

Aim 2:

When data combined from several countries are published, it is a general measure of quality to know, if there is cross-cultural DIF, and if there is, that this DIF is corrected for, before data are pooled. This was first suggested in 2004[22], but it has not been assessed for PROMs that are relevant for musculoskeletal research.

For KOOS, this study showed that data can be pooled from 1 of the 5 sub-scales without conversion and for 2 sub-scales if scores are corrected for cross-country DIF by conversion. For 2 sub-scales, pooling of data is not meaningful. This is relevant when data from National clinical databases from several countries are published, or when data from studies in different countries are pooled. There are no examples within sports research where cross-country DIF has been considered in studies where results from several language areas are represented. For observational studies comparing different conditions or treatments (like the study in the opening case of this article) the error that cross-country DIF can introduce depends on the distribution of the conditions/treatments between countries. If for instance one treatment is tradition in one country and another treatment in the second country, comparison of the treatment results is affected by cross-country DIF. For randomized, controlled studies, where allocation to treatment arms is made separately in each country, the means of outcome in the two treatment arm are affected equally by a cross-country DIF, but the variation in the pooled data might increase, if cross-country DIF is not compensated for. If, however, allocation is made for the complete cohort, treatments may not be distributed evenly in each country, and a cross-country DIF may affect the mean of the outcomes and thereby the assessment of a possible difference in outcome of the two treatments. This could be the case for an international multicentre study with a central computer for allocation.

Conclusion:

About half of the PROMs were translated and adapted by accepted methods. However, the vast majority of translated PROMs have not been validated optimally and are therefore of questionable quality, despite the common individual conclusion of the actual PROM being a valid and reliable measurement tool. There is differential item functioning (DIF)

between Denmark, Norway and Sweden in relation to many items of KOOS, meaning that if data are pooled or compared between countries, this should be corrected for. For two sub-scales of KOOS, pooled data are not meaningful.

Perspectives:

Ideally, all translated and adapted PROMs should be produced according to standard principles, and in cases where this has not been done, it can be considered to re-translate the PROM. It can be considered for PROMs that have not been validated by modern test theory model methods to re-validate, for instance by use of already existing data. The methods for translation, adaption and validation should always be described in detail, when results obtained by translated PROMs are published, and if optimal methods have not been used, the implications for the results should be discussed. If PROM scores from different countries are compared or pooled, it should be known if there is cross-country DIF, and this can be assessed during the process of translation and cultural adaption. Data should be converted before pooling, if there is cross-country DIF.

Conflicts of interest.

All authors declare that they have no conflicts of interest in relation to this manuscript.

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KOOS subscale	DIF items	CFA Validation			Rasch validation		
		Chi-square	DF	P	Chi-square	DF	P
Pain	P2, P7	109.468	89	0.070	129.5	106	0.0602
Symptoms	all						
Sport	Sp4	31.8	31	0.425	91.3	71	0.0529
QoL	none	19.975	20	0.459	28.0	20	0.1098

Table 10: Evaluation of models with partial invariance. All models include local dependence/correlated error terms. For the Symptoms subscale no differential item functioning (DIF) equating was possible because all items showed DIF. KOOS = the Knee injury and Osteoarthritis Outcome Score. CFA = Confirmatory factor analysis.

KOOS Pain subscale			KOOS Sport subscale		
Denmark	Norway	Sweden	Denmark	Norway	Sweden
0,0	0,0	0,0	0	0,0	0,0
3,7	3,8	2,3	5	5,0	5,3
7,4	7,6	5,2	10	9,8	10,4
11,1	11,2	8,8	15	14,5	15,4
14,8	14,8	12,8	20	19,2	20,3
18,5	18,3	16,9	25	24,0	25,1
22,2	21,7	21,1	30	28,8	29,9
25,9	25,2	25,3	35	33,6	34,6
29,6	28,6	29,5	40	38,5	39,2
33,3	32,1	33,8	45	43,4	43,8
37,0	35,7	38,0	50	48,2	48,3
40,7	39,3	42,1	55	53,1	52,8
44,4	42,9	46,1	60	57,8	57,3
48,1	46,6	49,9	65	62,6	62,0
51,9	50,3	53,6	70	67,5	66,9
55,6	54,0	57,2	75	72,5	72,3
59,3	57,7	60,8	80	77,7	77,8
63,0	61,4	64,3	85	82,9	83,4
66,7	65,0	67,7	90	88,1	88,8
70,4	68,6	71,1	95	93,2	94,1
74,1	72,2	74,4	100	100,0	100,0
77,8	75,7	77,7			
81,5	79,2	80,9			
85,2	82,7	84,2			
88,9	86,4	87,6			
92,6	90,4	91,2			
96,3	94,9	95,3			
100,0	100,0	100,0			

585

586 Table 11. Conversion tables for adjusting for cross-cultural differential item functioning (DIF).

587

Article ten in a series of ten.

How to translate and locally adapt a PROM. Assessment of cross-cultural differential item functioning.

Supplementary material.

Box 1: Forward-backward translation.

1. The PROM is forward translated separately from the original language by at least 2 translators, who have the local language as their mother tongue and are fluent in the language of the original version. It is recommended that one translator is informed about the purpose of the translation and has a professional healthcare background, while the other is uninformed and is not involved in healthcare.

2. The translated versions are compared, and differences, wordings, and possibly necessary adaptions of the items caused by differences in life conditions (for instance different metric systems, differences in housing traditions or type of popular sports) are discussed in a panel consisting of the translators and a moderator. The moderator can be one person but is often a group of various persons with expertise in health care, psychometrics, and language and sometimes patients. One conjoined version is produced.

3. The synthesized version is *translated back* to the original language by one, two or more bilingual, often professional translators, who are blinded to the original version of the questionnaire and to each other, and who are not informed about the purpose of the translation. The back translations are reconciled and any discrepancy between this version and the original version is discussed by the panel, into which the back-translators are now included. This can be a free discussion or based on a scoring system, according to which each member of the panel indicates for every item if there is full agreement between the back-translated version and the original version or not, and all discrepancies are discussed. If this results in changes in the translated questionnaire, a new back-translation is performed and the process is repeated, until there are no important differences.

4. Involvement of relevant patients and healthy persons for *pre-testing* of the accepted translated version is traditionally recommended at this stage, but it can be an advantage with inputs from a smaller group (typically 5-10 persons) before the translated PROM is back-translated (i.e., after step 2), so problems related to wording and local culture can be discussed with non-professionals early in the process. Ideally, pre-testing is performed by cognitive interviews with healthy persons and patients concerning understandability, meaning and relevance of each item in the PROM. However, in many cases the patients (ideally 30-40 persons) are just asked to fill the questionnaire out and state if it is understandable. If certain items are often left blank or commented on, they are discussed by the panel and eventually adapted further. This does not provide as much information as cognitive interviews.

5. The final back-translated and adapted version is sent to the PROM originator, who can accept it or suggest changes to the panel.

Box 2: Dual-panel translation.

1. Bilingual Panel: The actual translation is produced by a panel of typically 3-5 persons, fluent in both the target and the source language. The panel works together in consensus to produce the most appropriate translation. Emphasis is on a conceptually equivalent translation (i.e., the goal is to translate the meaning of the items where linguistic equivalence is of secondary importance). Panel members should represent the population the PROM is targeting in terms of age, gender, and sociodemographic characteristics. Professional translators and clinical research persons should generally be excluded, although one of the PROM developers can participate in order to explain possible contextual questions regarding the generation of items.

2. Lay Panel: The translated PROM produced by the bilingual panel is then assessed by a panel of 'lay persons' who are locals in the target setting. These persons are not proficient in the original source language and they have no relationship to the disease or disorder covered by the PROM. The Lay Panel discusses the items as a group, rewording items if deemed necessary. They may suggest testing out alternative wordings of items with actual patients in cognitive debriefing interviews, which is the next step in the translation process.

3. Cognitive debriefing interviews: Individual face-to-face interviews are conducted with a series of relevant patients in the target setting by a qualified interviewer. The interviewee is asked to complete the translated PROM in a "talk-out-loud" manner in the presence of the interviewer, but as though he or she were alone. Any problems are noted by the interviewer who probes the 'understandability' and relevance of the questions.

Details of recorded information:

For this study, the following information was recorded for each translated version of these 61 PROMs:

First, the method of translation was identified (e.g., forward-backward translation, dual-panel translation, or other methods).

If the dual-panel translation method had not been used, the articles were scrutinized for whether the researchers had tested ease of completion, understandability, and transfer of the meaning of the items using laypersons and patients in groups and single interviews. Moreover, if problems were identified in the groups or single person interviews, were the necessary modifications conducted, so the wording and meaning of the items functioned well in the new language context? In addition, it was recorded if the final version of the translated PROM had been discussed with relevant patients for functionality and relevance.

Second, it was assessed whether test of unidimensionality and DIF had been performed in a dataset in the new language setting by an IRT method or by confirmatory factor analysis (CFA).

Finally, it was assessed if tests of cross-cultural construct validity had been conducted (i.e., test of DIF across the different language versions of the PROM with datasets from the original version and the translated version). This means that validity should be tested in each dataset and the combined (pooled) dataset using modern test theory.

Supplementary: Tabel 1-9:

Neck PROMs translation

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural DIF tested	Comments
NDI Neck Disability Index									
Arabic (Shaheen et al. 2013) (1)	No	Yes	No	Yes	Yes	Yes	No	No	
Brazilian-Portuguese (Cook et al. 2006) (2)	No	Yes	No	No	No	No	No	No	
Chinese (Wu et al. 2010) (3)	No	Yes	No	Test	Yes	Unclear	No	No	
Danish (Lauridsen et al. 2017) (4)	No	Yes, but undocumented.	No	No, not documented	No	No	Yes	No	Apparently compared to a translation by the Mapigoup (www.mapigroup.com/Services/Linguistic-validation), no longer available from the indicated homepage
Dutch (Jorritsma et al. 2010) (5)	No	Yes, see comment	No	Yes	Yes	Yes	No	No	Back translator was a spine researcher who must know the English version
Dutch (Ailliet et al. 2013) (6)	No	No	Yes, see note	Yes	Yes	Yes	Yes	No	Backtranslation of an unpublished Dutch version
Finnish (Salo et al. 2010) (7)	No	Yes, see comment	No	No	No	No	No	No	Translated version was compared to an un-authorized existing Finnish translation and a consensus was made
French (Wlodyka-Demaille et al. 2002) (8)	No	Yes	No	Yes	Unclear	Yes	No	No	
German (Swanenburg et al. 2014a) (9)	No	Yes	No	Test	Yes	No	No	No	
Greek (Trouli et al. 2008) (10)	No	Yes	No	Yes	Yes	Yes	No	No	
Hebrew	No	Yes	No	Test	Yes	No	No	No	

(Shashua et al. 2016) (11)									
Iranian (Mousavi et al. 2007) (12)	No	Yes	No	Yes	Yes	Yes	No	No	
Italian (Monticone et al. 2012a) (13)	No	Yes	No	Yes	Yes	No	No	No	
Japanese (Nakamaru et al. 2012) (14)	No	Yes	No	Yes	Yes	Yes	No	No	
Japanese (Takeshita et al. 2012) (15)	No	Yes, but numbers of translators not specified	No	Yes, but unclear	Yes	Yes	No	No	
Korean (Song et al. 2010) (16)	No	Yes	No	Yes	Yes	Yes	No	No	
Marathi (Joseph et al. 2015) (17)	No	Yes	No	Yes	Yes	Yes	No	No	
Polish (Misterska et al. 2011) (18)	No	Yes	No	No	No	No	No	No	
Polish (Guzy et al. 2013) (19)	No	Yes	No	Yes	Yes	Unclear	Yes	No	
Portuguese (Cruz et al. 2015) (20)	No	No	Yes, an expert group reviewed the earlier version and found it OK	Yes	Yes	No	No	No	The original translation is unpublished but was available from www.mapigroup.com/Services/Linguistic-validation (no more available)
Russian (Bakhtadze et al. 2015) (21)	No	Yes	No	No	No	No	No	No	
Serbian (Jovicic et al. 2018) (22)	No	Yes	No	Yes	Yes	Yes	No	No	
Spanish (Ortega et al. 2008) (23)	No	Yes	No	Unclear	Unclear	Unclear	No	No	
Taiwanese (Lue et al. 2018) (24)	No	Yes	No	Yes	Yes	Yes	No	No	
Thai (Uthaikhup et al. 2011) (25)	No	Yes	No	Test	Yes	No	No	No	

Turkish (Aslan et al. 2009) (26)	No	Yes	No	Yes	Yes	Yes	No	No	
Turkish (Kesiktas et al. 2012) (27)	No	Yes	No	Yes	Yes	Yes	No	No	
Urdu (Farooq et al. 2017) (28)	No	Yes	No	Yes	Yes	Yes	No	No	

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Tabel 1: Translation, adaption and validation of neck-PROMs.

Shoulder PROMs translation

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural DIF tested	Comments
ASES *American Shoulder and Elbow Surgeons for shoulder patients*									
Arabic (Yahia et al. 2011) (29)	No	Yes	No	Test	No	No	No	No	
Brazilian-Portuguese (Knaut et al. 2010) (30)	No	Yes	No	Yes	Yes	Yes	No	No	
Dutch (Felsch et al. 2019) (31)	No	Yes	No	Test	Yes	Yes	No	No	
Finnish (Piitulainen et al. 2014) (32)	No	Yes	No	No	No	No	No	No	
Italian (Padua et al. 2010) (33)	No	Yes	No	No	No	No	No	No	
Spanish (Vrotsou et al. 2016) (34)	No	Yes	No	Yes	Yes	Yes	Yes	No	
Spanish	No	Yes	No	Yes	Yes	Yes	No	No	

(Policastro et al. 2019) (35)									

Constant Murley Score

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural DIF tested	Comments
Brazilian Portuguese (Barreto et al. 2015) (36)	No	Yes	No	Test	Yes	Yes	No	No	
Chinese (Yao et al. 2017) (37)	No	Yes	No	Test	Yes	Yes	No	No	
Danish (Moeller et al. 2014) (38)	No	Yes	No	Yes	Yes	Yes	No	No	

DASH
Disabilities of the arm, shoulder and hand

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural DIF tested	Comments
Chinese (Lee et al 2004, and Lee et al. 2005) (39)	No	No	Yes, direct	No	No	No	No	No	
Chinese (Chen et al. 2015) (40)	No	Yes	No	No	No	No	No	No	
Chinese (Chan et al. 2019) (41)	No	Yes	No	Yes	Yes	Yes	No	No	
Danish (Schönnemann et al. 2011) (42)	?	?	?	?	?	?	?	?	No published translation article
German	No	Yes	No	No	No	No	No	No	

(Offenbächer et al. 2002) (43)									
Greek (Themistocleous et al. 2006) (44)	No	Yes	No	No	No	No	No	No	
Igbo (Ibikunle et al. 2017) (45)	No	Yes	No	Yes	Yes	Yes	Yes	No	
Italian (Padua R et al 2003, and Franchignoni et al. 2010) (46)	No	Yes	No	Yes	Yes	Yes	Yes	No	
Korean (Lee et al. 2008) (47)	No	Yes	No	Yes	Yes	Yes	No	No	
Nepali (Sudarshan et al. 2019) (48)	No	Yes	No	Yes	Yes	Yes	No	No	
Norwegian (Finsen V et al 2008, and Haldorsen et al. 2014) (49)	No	No	Yes	No	No	No	No	No	
Persian (Mousavi et al. 2008) (50)	No	Yes	No	Yes	Yes	Yes	No	No	
Portuguese (Orfale AG et al 2005, and Cheng et al. 2009) (51)	No	Yes	No	Yes	Yes	Yes	No	No	
Swedish (Atroshi et al. 2000) (52)	No	Yes	No	Yes	Yes	Yes	No	No	
Swedish (Atroshi I et al 2000, and Gummesson et al. 2003) (53)	No	Yes	No	Yes	Yes	Yes	No	No	
Tamil (Srikesavan et al. 2019) (54)	No	Yes	No	Test	Yes	No	No validation	No validation	
Thai (Tongprasert et al. 2014) (55)	No	Yes	No	Test	Yes	Yes	No	No	
Thai	No	Yes	No	Yes	Yes	Yes	No	No	

(Jianmongkol S et al 2011) (56)									
Turkish (Kitis et al. 2009) (57)	?	?	?	?	?	?	?	?	No translation articles published in English, German or Nordic languages
Yoruba (Odole AC et al 2016) (58)	No	Yes	No	Yes	Yes	Yes	No	No	

OISS
Oxford Instability Shoulder Score

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural DIF tested	Comments
Dutch (van der Linde et al. 2015) (59)	No	Yes	No	Yes	Yes	Yes	No	No	
Italian (Mazzoni et al. 2018) (60)	No	Yes	No	Yes	Yes	Yes	No	No	
Norwegian (Skare et al. 2013) (61)	No	Yes	No	No	No	No	No	No	
Turkish (Sonmezer et al. 2018) (62)	No	Yes	No	Yes	Yes	Yes	Yes	No	

OSS
Oxford Shoulder Score

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural DIF tested	Comments
Brazilian-Portuguese	No	Yes	No	Test	Yes	Yes	No	No	

(Lima et al. 2016) (63)									
Chinese (Xu et al. 2015) (64)	No	Yes	No	Yes	Yes	Yes	No	No	
Danish (Frich et al. 2011) (65)	No	Yes	No	No	No	No	No	No	
Dutch (Berendes et al. 2010) (66)	No	Yes	No	Yes	Yes	Yes	No	No	
French (Tuton et al. 2016) (67)	No	Yes	No	Yes	Yes	Yes	No	No	
German (Huber et al. 2004) (68)	No	Yes	No	Test	Yes	No	No	No	
Italian (Murena et al. 2010) (69)	No	Yes	No	Yes	Yes	Yes	No	No	
Korean (Roh et al. 2012) (70)	No	Yes	No	Test	Yes	No	No	No	
Persian (Ebrahimzadeh et al. 2015a) (71)	No	Yes	No	No	No	No	No	No	
Persian (Naghdi et al. 2015) (72)	No	Yes	No	Yes	Yes	Yes	No	No	
Portuguese (Goncalves et al. 2018) (73)	No	Yes	No	Yes	Yes	Yes	No	No	
Romanian (Haragus et al. 2018a) (74)	Not described	Not described	Not described	Not described	Not described	Not described	No	No	
Spanish (Torres-Lacomba et al. 2015) (75)	No	Yes	No	Yes	Yes	Yes	No	No	
Turkish (Tugay et al. 2010) (76)	No	Yes	No	Test	Yes	No	No	No	

PROMIS UE
Patient-Reported Outcomes Measurement Information System Upper Extremity

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural DIF tested	Comments
Dutch (Voshaar et al 2012, and Bruggen et al. 2019) (77) *v2.0 46 items*	No	Yes	No	Yes	Yes	Yes	No test, but yes in linked referenc e	No test, no cross-cultural DIF in linked reference	
German (Liegl et al. 2018) (78) *v1.2 16 items*	No	Yes	No	Yes	Yes	Yes	Yes	No	
Spanish (Hays et al. 2013) (79)	Not describd	Not described	Not described	Not descri bed	Not describe d	-Not describ ed	Not describe d	Not described	-
Q-DASH *Quick-DASH*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural DIF tested	Comments
Chinese (Cao et al. 2019) (80)	No	Yes	No	Yes	Yes	Yes	No	No	
Danish (Schönnemann, Eggers, 2016) (81)	?	?	?	?	?	?	No	No	No information about translation
Dutch (Iordens et al. 2017) (82)	?	?	?	?	?	?	?	?	No information about translation
French (Fayad et al. 2009) (83)	No	No	No	No	Yes	No	No	No	Not translated but the French full version was used
Italian (Franchignoni et al. 2011) (84)	?	?	?	?	?	?	Yes	No	No information about translation

Japanese (Imaeda et al. 2006) (85)	?	?	?	?	?	?	No	No	No information about translation
Swedish (Gummesson et al. 2006) (86)	?	?	?	?	?	?	No	No	No information about translation
Rowe Score The Rowe Score for Instability									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tested in translated version	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Marcondes et al. 2012a) (87)	No	Yes	No	Yes	Yes	Yes	Not tested	Not tested	
Rowe score, modified PROMs									
Brazilian-Portuguese (Marcondes et al. 2012b) (88) *For overhead athletes*	No	Yes	No	Yes	Yes	Yes	Not tested	Not tested	
SANE *Single Assessment Numeric Evaluation score, shoulder*									
	Conditions validated (n)	Different phases	Normals validated (n)	IRT method	Comparision with other PROMs	Other factor analyses	Domain aggregation	Test-retest reliability	Cronbach's α
Dutch (Theeuwen et al. 2019) (89)	No	Yes	No	Yes	Yes	Yes	No	No	
SPADI *Shoulder Pain and Disability Index*									

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tested in translated version	Cross-cultural DIF tested	Comments
Arabic (Alsanawi et al. 2015) (90)	No	Yes	No	Yes	Yes	Yes	No	No	
Brazilian-Portuguese (Martins et al. 2010) (91)	No	Yes	No	Yes	Yes	Yes	No	No	
Chinese (Yao et al. 2017) (92)	No	Yes	No	Yes	Yes	Yes	No	No	
Chinese (Wang et al. 2018) (93)	No	Yes	No	Yes	Yes	Yes	No	No	
Danish (Christiansen et al. 2013) (94)	No	Yes	No	No	No	No	No	No	
Dutch (Graaf et al. 2015) (95)	?	?	?	?	?	?	No	No	No translation article accessible
German (Angst et al. 2007) (96)	No	Yes	No	Yes	Yes	Yes	No	No	
Greek (Vrouva et al. 2016) (97)	No	Yes	No	Yes	Yes	Yes	No	No	
Italian (Marchese et al. 2012) (98)	No	Yes	No	No	No	No	No	No	
Nepali (Sudarshan et al. 2019) (99)	No	Yes	No	Yes	Yes	Yes	No	No	
Persian (Ebrahimzadeh et al. 2015b) (100)	No	Yes	No	Yes	Yes	Yes	No	No	
Slovene (Jamnik, Spevak, 2008) (101)	No	Yes	No	No	No	No	No	No	
Spanish (Torres-Lacomba et al. 2015) (75)	No	Yes	No	Yes	Yes	Yes	No	No	

Spanish (Membrilla-Mesa et al. 2015) (102)	No	Yes	No	Yes	Yes	Yes	No	No	
Tamil (Jeldi et al. 2012) (103)	No	Yes	No	Test	Yes	No	No	No	
Thai (Phongamwong, Choosakde, 2015) (104)	No	Yes	No	Test	Yes	No	No	No	

SST
The Simple Shoulder Test

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tested in translated version	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Neto et al. 2013) (105)	No	Yes	No	Yes	Yes	Yes	Yes	No	
Dutch (Kampen et al. 2012) (106)	No	Yes	No	?	?	?	Yes	No	
Italian (Marchese et al. 2012) (98)	No	Yes	No	No	No	No	No	No	
Persian (Naghdi et al. 2015) (72)	No	Yes	No	Yes	Yes	Yes	No	No	
Persian (Ebrahimzadeh et al. 2016) (107)	No	Yes	No	Yes	Yes	Yes	No	No	
Spanish (Membrilla-Mesa et al. 2015) (108)	No	Yes	No	No	No	No	No	No	

WORC
The Western Ontario Rotator Cuff Index

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tested in translated version	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Lopes et al 2006, and Lopes et al. 2008) (109)	No	Yes	No	Yes	Yes	Yes	No		
Canadian-French (St-Pierre et al. 2015) (110)	No	Yes	No	Yes	Yes	Yes	No	No	
Chinese (Wang et al. 2017) (111)	No	Yes	No	Yes	Yes	Yes	No	No	
Dutch (Wiertsema et al. 2013) (112)	No	Yes	No	No	No	No	No	No	
Dutch (Wessel et al. 2013) (113)	No	Yes	No	Yes	Yes	Yes	No	No	
English (Kirkley et al. 2003) (114)									
English (Wessel et al. 2005) (115)									
Japanese (Kawabata et al. 2013) (116)	No	Yes	No	No	No	No	No	No	
Persian (Mousavi et al. 2009) (117)	No	Yes	No	Yes	Yes	Yes	No	No	
Polish (Bejer et al. 2018) (118)	No	Yes	No	Yes	Yes	Yes	No	No	
Swedish (Zhaeentan et al. 2016) (119)	?	?	?	?	?	?	No	No	No accessible translation article
Turkish (El et al. 2006) (120)	No	Yes	No	Yes	Yes	No	No	No	

WOSI

The Western Ontario Shoulder Instability Index

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tested in translated version	Cross-cultural DIF tested	Comments
Brazilian-Portguese (Barbosa et al. 2012) (121)	No	Yes	No	Yes	Yes	Yes	No	No	
Canadian- and Swiss-French (Gaudelli et el. 2015) (122)	No	Yes	No	No	No	No	No	No	
Danish (Eshoj et al. 2017) (123)	No	Yes	No	Yes	Yes	Yes	No	No	Danish version translated from Swedish version, merged with an unpublished Danish translation from English and back-translated into Swedish AND English !
French (Perrin et al. 2017) (124)	No	Yes	No	Yes	Yes	Yes	No	No	
German (Hofstaetter et al. 2010) (125)	No	Yes	No	Yes	Yes	Yes	No	No	
Hebrew (Gottlieb, Springer, 2019) (126)	No	Yes, but only one translator	No	Yes	Yes	Yes	No	No	
Italian (Cacchio et al. 2012a) (127)	No	Yes	No	Yes	Yes	Yes	No	No	
Japanese (Hatta et al. 2011) (128)	No	Yes, but only one translator	No	No	No	No	No	No	
Norwegian	No	Yes	No	No	No	No	No	No	

(Skare et al. 2013) (61)									
Spanish (Yuguero et al. 2016) (129)	No	Yes	No	Yes	Yes	Yes	No	No	
Swedish (Salomonsson et al. 2009) (130)	No	Yes	No	Yes	Yes	Yes	No	No	
Turkish (Basar et al. 2017) (131)	No	Yes	No	Test	Yes	No	No	No	

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Tabel 2: Translation, adaption and validation of shoulder PROMs.

Elbow PROMs translation

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated	Cross-cultural DIF tested	Comments
pASES-e *American Shoulder and Elbow Surgeons Elbow Questionnaire*									
German (John et al. 2010) (132)	No	Yes	No	Yes	Yes	Yes	No	No	
PRTEE *Patient-rated Tennis Elbow Evaluation*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated	Cross-cultural DIF tested	Comments
Canadian-French	No	Yes	No	Yes	Yes	Yes	No	No	

(Blanchette et al. 2010) (133)									
Dutch (van Ark et al. 2014) (134)	No	Yes	No	Yes	Undocumented	No	No	No	
French (Kaux et al. 2016a) (135)	No	Yes	No	Test	Yes	No	No	No	
Greek (Stasinopaulos et al. 2014) (136)	No	Yes	No	Test	Yes	No	No	No	
Italian (Cacchio et al. 2012b) (137)	No	Yes	No	Yes	Yes	Yes	No	No	
Swedish (Nilsson et al. 2008) (138)	No	Yes	No	Yes	Yes	No	No	No	

132. John M, Angst F, Awiszus F, King GJ, MacDermid JC, Simmen BR. The American Shoulder and Elbow Surgeons Elbow Questionnaire: cross-cultural adaptation into German and evaluation of its psychometric properties. J Hand Ther. 2010;23(3):301-13; quiz 14.
133. Blanchette MA, Normand MC. Cross-cultural adaptation of the patient-rated tennis elbow evaluation to Canadian French. J Hand Ther. 2010;23(3):290-9; quiz 300.
134. van Ark M, Zwerver J, Diercks RL, van den Akker-Scheek I. Cross-cultural adaptation and reliability and validity of the Dutch Patient-Rated Tennis Elbow Evaluation (PRTEE-D). BMC Musculoskelet Disord. 2014;15:270.
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137. Cacchio A, Necozione S, MacDermid JC, Rompe JD, Maffulli N, di Orio F, et al. Cross-cultural adaptation and measurement properties of the italian version of the Patient-Rated Tennis Elbow Evaluation (PRTEE) questionnaire. Phys Ther. 2012;92(8):1036-45.
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Tabel 3: Translation, adaption and validation of elbow PROMs.

Hand PROMs translation

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural	Comments
PRWE									

Patient-Rated Wrist Evaluation									
Brazilian-Portuguese (Rodrigues et al. 2015) (139)	No	Yes	No	Yes	Yes	No	No	No	
Czech, French, Hungarian, Italian, Brazilian-Portuguese, Russian, Ukrainian Goldhahn et al. 2013) (140)	No	Yes	No	Yes	Unclear	Yes	Not perfomed	Not performed	
Chinese, English (Weixin, Seow, 2004) (141)	No	Yes	No	Yes	Yes	Undocumented	No	No	
Chinese (Wah et al. 2005) (142)	No	No	Yes, one frwardtranslator and a panel. No Backwards translation	Test	Yes	No	No	No	
Danish (Schønneman n et al. 2013) (143)	Yes	No	No	Yes	Yes	Yes	No	No	
Finnish (Sandelin et al. 2016) (144)	No	Yes	No	Test	Yes	No	No	No	
German (John et al 2008) (145)	No	Yes	No	Yes	Uncertain	Yes	No	No	
Hindi (Mehta et al. 2012) (146)	No	Yes	No	Yes	No	Yes	No	No	
Japanese (Imaeda et al. 2010) (147)	No	Yes	No	Unclear	Unclear	Unclear	No	No	
Korean	No	Yes	No	Test	Yes	Unclear	No	No	

(Kim, Kang, 2013) (148)									
Persian (Hassankhani et al 2017) (149)	No	Yes	No	Test	Yes	No	No	No	
Polish (Czarnecki et al. 2015) (150)	No	Yes	No	Yes,but unclear	Yes	Unclear	No	No	
Spanish (Alfie et al. 2017) (151)	No	Yes	No	Yes	Yes	Yes	No	No	
Spanish, 2017 (Rosales et al. 2017) (152)	No	Yes	No	No	No	No	No	No	
Swedish (Navarro et al. 2011) (153)	No	Yes	No	Yes	Yes	Yes	No	No	
Swedish (Lövgren, Hellstrôm, 2012) (154)	No	Yes, but only one forward translator	No	No	No	No	No	No	
Turkish (Öztürk et al. 2015) (155)	No	Yes	No	Test	Yes	Unclear	No	No	
PRWE modified PROMs									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural adaption)	Dimensionality tsted in translated version	Cross-cultural DIF tested	Comments
Arabic *PRWHE-form* (Hasani et al. 2015) (156)	No	Yes	No	Yes	Yes	Yes	No	No	
Italian *PRWHE-form* (Fairplay et al. 2012) (157)	No	Yes	No	No	No	No	No	No	
Turkish *PRWHE-form* (Topcu, Afsar, 2019) (158)	No	Yes	No	Test	Yes	Unclear	No	No	
139. da Silva Rodrigues EK, de Cassia Registro Fonseca M, MacDermid JC. Brazilian version of the Patient Rated Wrist Evaluation (PRWE-BR): Cross-cultural adaptation, internal consistency, test-retest reliability and construct validity. J Hand Ther. 2015;28(1):69-75; quiz 6									

140. Goldhahn J, Shisha T, Macdermid JC, Goldhahn S. Multilingual cross-cultural adaptation of the patient-rated wrist evaluation (PRWE) into Czech, French, Hungarian, Italian, Portuguese (Brazil), Russian and Ukrainian. Arch Orthop Trauma Surg. 2013;133(5):589-93.
141. Xu W, Seow C. Chinese version of patient rated wrist evaluation (PRWE): cross-cultural adaptation and reliability evaluation. Ann Acad Med Singapore. 2003;32(5 Suppl):S48-9.
142. Wah JW, Wang MK, Ping CL. Construct validity of the Chinese version of the Patient-rated Wrist Evaluation Questionnaire (PRWE-Hong Kong Version). J Hand Ther. 2006;19(1):18-26, quiz 7.
143. Schonnemann JO, Hansen TB, Soballe K. Translation and validation of the Danish version of the Patient Rated Wrist Evaluation questionnaire. J Plast Surg Hand Surg. 2013;47(6):489-92.
144. Sandelin H, Jalanko T, Huhtala H, Lassila H, Haapala J, Helkamaa T. Translation and Validation of the Finnish Version of the Patient-Rated Wrist Evaluation Questionnaire (PRWE) in Patients with Acute Distal Radius Fracture. Scand J Surg. 2016;105(3):204-10.
145. John M, Angst F, Awiszus F, Pap G, Macdermid JC, Simmen BR. The patient-rated wrist evaluation (PRWE): cross-cultural adaptation into German and evaluation of its psychometric properties. Clin Exp Rheumatol. 2008;26(6):1047-58.
146. Mehta SP, Mhatre B, MacDermid JC, Mehta A. Cross-cultural adaptation and psychometric testing of the Hindi version of the patient-rated wrist evaluation. J Hand Ther. 2012;25(1):65-77; quiz 8.
147. Imaeda T, Uchiyama S, Wada T, Okinaga S, Sawaizumi T, Omokawa S, et al. Reliability, validity, and responsiveness of the Japanese version of the Patient-Rated Wrist Evaluation. J Orthop Sci. 2010;15(4):509-17.
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150. Czarnecki P, Wawrzyniak-Bieleda A, Romanowski L. Polish Adaptation of Wrist Evaluation Questionnaires. Ortop Traumatol Rehabil. 2015;17(3):241-8.
151. Alfie V, Gallucci G, Boretto J, Donndorff A, Dubois JP, Benitez S, et al. Patient-Rated Wrist Evaluation: Spanish Version and Evaluation of Its Psychometric Properties in Patients with Acute Distal Radius Fracture. J Wrist Surg. 2017;6(3):216-9.
152. Rosales RS, Garcia-Gutierrez R, Reboso-Morales L, Atroshi I. The Spanish version of the Patient-Rated Wrist Evaluation outcome measure: cross-cultural adaptation process, reliability, measurement error and construct validity. Health Qual Life Outcomes. 2017;15(1):169.
153. Mellstrand Navarro C, Ponzer S, Tornkvist H, Ahrengart L, Bergstrom G. Measuring outcome after wrist injury: translation and validation of the Swedish version of the patient-rated wrist evaluation (PRWE-Swe). BMC Musculoskelet Disord. 2011;12:171.
154. Lovgren A, Hellstrom K. Reliability and validity of measurement and associations between disability and behavioural factors in patients with Colles' fracture. Physiother Theory Pract. 2012;28(3):188-97.
155. Ozturk O, Sari Z, Ozgul B, Tasyikan L. Validity and reliability of the Turkish "Patient-Rated Wrist Evaluation" questionnaire. Acta Orthop Traumatol Turc. 2015;49(2):120-5.
156. Hasani FN, MacDermid JC, Tang A, Kho ME. Cross-cultural adaptation and psychometric testing of the Arabic version of the Patient-Rated Wrist Hand Evaluation (PRWHE-A) in Saudi Arabia. J Hand Ther. 2015;28(4):412-9; quiz 20.
157. Fairplay T, Atzei A, Corradi M, Luchetti R, Cozzolino R, Schoenhuber R. Cross-cultural adaptation and validation of the Italian version of the patient-rated wrist/hand evaluation questionnaire. J Hand Surg Eur Vol. 2012;37(9):863-70.
158. Oke Topcu D, Ikbali Afsar S. Reliability, validity, and cross-cultural adaptation study of the Turkish version of the Patient-Rated Wrist/Hand Evaluation questionnaire. Turk J Med Sci. 2019;49(2):574-82

Tabel 4: Translation, adaption and validation of hand PROMs.

Hip PROMs translation

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments

HAGOS Copenhagen Hip and Groin Outcome Score									
Chinese (Cao et al. 2018) (159)	No	Yes	No	Test	Yes	No	No	No	From English
English (Thorborg et al. 2011) (160)	?	?	?	?	?	?	?	?	No description of translation from Swedish to English
Dutch (Brans et al. 2016) (161)	No	Yes	No	Yes	Yes	Yes	Yes	No	From English
Dutch (Tak et al. 2018) (162)	No	Yes	No	Yes	Yes	Yes	No	No	From Danish
Swedish (Thomeé et al. 2013) (163)	No	Yes	No	Yes	No	Yes	No	No	

HOOS *Hip Disability and Osteoarthritis Outcome Score*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Machado et al. 2019) (164)	No	Yes	No	Test	Yes	No	No	No	From English
Chinese (Wei et al. 2012) (165)	No	Yes	No	Undoc ument ed	Undocu mented	Und ocu men ted	No	No	Probably from English
Dutch (de Groot et al. 2006) (166)	No	Yes	No	Test	Yes	No	No	No	From Swedish
French (Ornetti et al. 2010) (167)	No	Yes	No	Test	Yes	No	No	No	From English
German (Blasimann et al. 2014) (168)	No	Yes, but only described in art	No	Yes	No	Yes	No	No	From English

German (Arbab et al. 2017) (169)	No	Yes	No	Test	Yes	No	No	No	From English, no difference compared to Swiss-German translation
Italian (Torre et al. 2018) (170)	No	Yes	No	Test	Yes	No	No	No	From English
Japanese (Satoh et al. 2013) (171)	No	Yes	No	Test	No	No	No	No	From English
Korean (Lee et al. 2011) (172)	No	Yes	No	Test	Yes	No	No	No	From English
Persian (Mousavian et al. 2018) (173)	No	Yes	No	Test	Yes	No	No	No	From English
Polish (Glinkowski et al. 2019) (174)	No	Yes	No	Test	Yes	No	No	No	From English
Romanian (Haragus et al. 2018a) (175)	No documented	Not documented	Not documented	Not documented	Not documented	Not documented	No	No	From English
Swedish (Nilsdotter et al. 2003) (176)									English version undocumented
Thai (Trathitiphan et al. 2016) (177)	No	Yes	No	Test	Yes	No	No	No	From English
HOOS modified PROMs									
Austria, Canada, Finland, France, Germany, Hungary, Iceland, Italy, Poland, Spain, Sweden, Switzerland, United Kingdom (Davis et al. 2008) (178) *5-item physical function*	?	?	?	?	?	?	Yes	Cross-country DIF	English translation undocumented

subscale short form									
Danish (Paulsen et al. 2012a) (179) *Physical function-, pain- and QoL-subscales*	?	?	?	?	?	?	No	No	Danish translation undocumented
Danish (Paulsen et al. 2013) (180) *Physical function-, pain- and QoL-subscales*	?	?	?	?	?	?	No	No	Danish translation undocumented
Turkish (Yilmaz et al. 2014) (181) *5-item physical function subscale short form*	No	Yes	No	Test	Yes	No	No	No	From English

THR: *Total Hip Replacement*

HOS
Hip Outcome Score

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (de Oliveira et al. 2014) (182)	No	Yes	No	Yes	Yes	Yes	Not perf orm ed	Not perf orm ed	
German (Naal et al. 2011) (183)	No	Yes, but not document ed	No	Test	Yes	No	No	No	
Korean (Lee et al. 2014a) (184)	No	Yes	No	Yes	Yes	Yes	No	No	
Spanish (Seijas et al. 2014) (185)	No	Yes	No	Test	Yes	No	No	No	

Turkish (Polat et al. 2017) (186)	No	Yes	No	Yes	Yes	Yes	No	No	

iHOT-12
International Hip Outcome Tool 12 items

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Polesello et al. 2012) (187)	No	Yes	No	Yes	Yes	Yes	Not perf orm ed	Not perf orm ed	
Dutch (Stevens et al. 2015) (188)	No	Yes	No	No	No	No	No	No	
German (Baumann et al. 2016a) (189)	No	Yes	No	Test	Yes	No	No	No	
Japanese (Watanabe et al. 2018) (190)	No	Yes	No	Yes	Yes	Yes	No	No	
Swedish (Jónasson et al. 2014) (191)	No	Yes	No	Yes	No	Yes	No	No	

iHOT-33
International Hip Outcome Tool 33 items

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Polesello et al. 2012) (187)	No	Yes	No	Yes	Yes	Yes	Not perf orm ed	Not perf orm ed	
Dutch (Tijssen et al. 2018) (192)	No	Yes	No	Yes	Yes	Yes	No	No	
German	No	Yes	No	Test	Yes	No	No	No	

(Baumann et al. 2016b) (193)									
Spanish (Ruiz-Íban et al. 2015) (194)	No	Yes	No	Test	Yes	No	No	No	

LEFS
Lower Extremity Functional Scale

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Arabic (Alnahdi et al. 2016) (195)	No	Yes	No	Test	Yes	No	No	No	
Arabic (Korakakis et al. 2019) (196)	No	Yes	No	Yes	Yes	Yes	Yes	No	
Brazilian-Portuguese (Metsavaht et al. 2012) (197)	No	Yes	No	Test	Yes	No	No	No	
Brazilian-Portuguese (Pereira et al. 2013) (198)	No	Yes	No	Yes	Yes	Yes	No	No	
Dutch (Hoogeboom et al. 2012) (199)	No	Yes	No	Yes	Yes	Yes	No	No	
Finnish (Repo et al. 2017) (200)	No	Yes	No	Yes	Yes	Yes	No	No	
German (Naal et al. 2015) (201)	No	Yes, but not documented	No	Not documented	Not documented	Not documentet	No	No	
Gujarati (Brahmbhatt, Sheth, 2018) (202)	No	Yes	No	Test	Yes	No	No	No	
Italian	No	Yes	No	Yes	Yes	Yes	No	No	

(Cacchio et al. 2010) (203)									
Malaysian (Yunus et al. 2017) (204)	No	Yes	No	No	No	No	No	No	
Persian (Negahban et al. 2014) (205)	No	Yes	No	Yes	Yes	Yes	No	No	
Spanish (Cruz-Díaz et al. 2014) (206)	No	Yes	No	No	No	No	No	No	
Taiwan-Chinese (Hou et al. 2014) (207)	No	Yes	No	No	No	No	No	No	
Turkish (Citaker et al. 2016) (208)	No	Yes	No	Test	Yes	No	No	No	

NAHS
Non-arthritic Hip Score

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (del Castillo et al. 2013) (209)	No	Yes	No	Yes	Yes	Yes	No	No	

OHS
Oxford Hip Score

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Chinese (Zheng et al. 2014) (210)	No	Yes, but only one forward translator	No	Test	Yes	No	No	No	

Danish (Paulsen et al. 2012b) (211)	No	Yes, but only one forward translator	No	Yes	Yes	Yes	No	No	
German (Naal et al. 2008a) (212)	No	Yes	No	Test	Yes	No	No	No	
Iranian (Nourbakhsh et al. 2013) (213)	No	Yes	No	Yes	Yes	Yes	No	No	
Italian (Martinelli et al. 2011) (214)	No	Yes	No	Yes	Yes	Yes	No	No	
Korean (Lee et al. 2014b) (215)	No	Yes	No	Yes	Yes	Yes	No	No	
Romania (Haragus et al. 2018b) (216)	No	Yes	No	Yes	Yes	Undocumented	No	No	
Spanish (Martin-Fernández et al. 2017) (217)	?	?	?	?	?	?	?	?	The Spanish tranlation is undocumented
Turkish (Tugay et al. 2015) (218)	No	Yes	No	Test	Yes	No	No	No	
OHS modified PROMs									
Dutch (Gosens et al. 2009) (219)	No	Yes	No	Yes	Yes	Yes	No	No	From the English 2002 translation
Japanese (Uesugi et al 2006, and Uesugi et al. 2009) (220)	No	Yes	No	? Article in Japanese	? Article in Japanese	? Article in Japanese	No	No	
WOMAC *Western Ontario and McMaster Universities Osteoarthritis Index*									

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tested in	Cross-cultural DIF tested	Comments
Dutch (Roorda et al. 2003) (221)	?	?	?	?	?	?	?	?	The Dutch translation has apparently never been published.
Finnish (Soininen et al. 2008) (222)	No	Yes, see comment	No	No	No	No	No	No	Translation by a professional company, and it was "checked for linguistic clearness and compared to a validated Swedish version of the questionnaire"
German (Ryser et al. 1999) (223)	?	?	?	?	?	?	?	?	The German translation is from 1996 and published in German
Persian (Nadrian et al. 2012) (224)	No	Yes	No	Yes	Yes	No	No	No	
Spanish (Escobar et al. 2002) (225)	?	?	?	?	?	?	?	?	The Spanish translation is from 1999 and published in Spanish
WOMAC modified PROMs									
Canadian-French (Tubach et al. 2005) (226) *8-item short form*	?	?	?	?	?	?	?	?	The French-Canadian translation was apparently published in Arthritis Rheum in 1994 but it is not available

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Tabel 5: Translation, adaption and validation of hip PROMs.

Thigh PROMs translation

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
FASH *Functional Assessment Scale for Acute Hamstring Injuries*									
English (Malliaropuolos et al. 2014) (227)	?	?	?	Yes	No	Yes	No	No	Translated from Greek
French (Locquet et al. 2019) (228)	No	Yes	No	Test	Yes	No	No	No	Translated from the English version
German (Malliaropuolos et al. 2014) (227)	?	?	?	Yes	No	Yes	No	No	Translated from Greek

Spanish (Hernández-Sanchez et al. 2019) (229)	No	Yes	No	Undocument ed	Undocumented	Undocumented	No	No	

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Tabel 6: Translation, adaption and validation of thigh PROMs.

Knee PROMs validation

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
AIMS2 Arthritis Impact Measurement Scales 2									
Brazilian-Portuguese (Brandão et al. 1998**)** (230)	No	Yes	No	No	No	No	No	No	Process not described in detail
French (Pouchot et al. 1996a) (231)	No	Yes	No	Yes	Yes	Yes	No	No	Process not described in detail
French (Pouchot et al. 1996b) (232)	No	Yes	No	Yes	Yes	Yes	No	No	
German (Rosemann, Szecsenyi, 2007) (233)	No	Yes	No	Test	Yes	No	No	No	

Italian (Salaffi et al. 2000) (234)	No	No	Yes	No	No	No	No	No	
Persian (Mousavi et al. 2009) (235)	No	Yes	No	No	No	No	No	No	
Slovak (Soosova, Macejova, 2013) (236)	No	No	Yes direct translation	No	No	No	No	No	
Turkish (Atamaz et al. 2005) (237)	No	Yes	No	Yes	Yes	Yes	No	No	Process not described in detail
Chinese (Chu et al. 2004) (238) Added 2 items	No	Yes,but only one translator each way	No	No	No	No	No	No	
German (Rosemann et al. 2005) (239) 26-item short form	No	Yes	No	Yes	Yes	Yes	No	No	Process not described in detail
Norwegian (Haugen et al. 2011) (240) Hand and finger subscale only	?	?	?	?	?	?	?	?	Translation undocumented
Persian (Askary-Ashtiani et al. 2009a) (241) 26-item short form	No	Yes	No	Yes	Yes	Yes	No	No	
Persian (Askary-Ashtiani et al. 2009b) (242) 26-item short form	No	Yes	No	Test	Yes	Yes	No	No	

Cincinatti
Modified Cincinnati Knee Rating score

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Ramos Marinho et al. 2019) (243)	No	Yes	No	Ytst	Yes	No	No	No	

FJS-12
Forgotten Joint Score

FJS was developed by help from patients in Austria in German. There is no information about how the English version was produced.

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Ferreira et al. 2018) (244)	No	Yes	No	Yes	Yes	Yes	No validation	No validation	From English
Chinese (Cao et al. 2017) (245)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Dutch (Shadid et al. 2016) (246)	No	Yes	No	Yes	Yes	Yes	No	No	From German
German (Baumann et al. 2016c) (247)	No	Yes, but unclear	No	Test	Yes	No	No	No	From English
Swedish (Heijbel et al. 2019) (248)	Unknown	Unknown	Unknown	Yes	Yes	Yes	No	No	"Swedish translation provided by developers"
Japanese (Matsumoso et al 2015) (249)	No	Yes, but unclear	No	No	No	No	No	No	From English
French (Kloushea et al 2018) (250)	No	Yes	No	Test	Yes	No	No	No	From English

HSS *Hospital for Special Surgery Knee Scoring System*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
French (Narin et al. 2014) (251)	No	Yes	No	Yes	Yes	Yes	No	No	
Turkish (Neuprez et al. 2014) (252)	No	Yes	No	Test	Yes	No	No	No	
IKDC *International Knee Documentation Committee Subjective Knee Form*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Arabic (Ahmed et al. 2019) (253)	No	Yes	No	Yes	Yes	Yes	No	No	
Brazilian-Portuguese (Metsavaht et al. 2010) (254)	No	Yes	No	Test	Yes	No	No	No	
Chinese (Fu, Chan, 2011) (255)	No	Yes	No	Test	Yes	No	No	No	
Chinese (Huang et al. 2017) (256)	No	Yes	No	Yes	Yes	Yes	No	No	
Chinese (Jia et al. 2018) (257)	No	Yes	No	Test	Yes	No	No	No	
Dutch (Haverkamp et al. 2006) (258)	No	Yes	No	No	No	No	No	No	

German (Kümmel et al. 2018) (259)	?	?	?	?	?	?	?	?	The translation process of the German version is undocumented
Greek (Koumantakis et al. 2016) (260)	No	Yes	No	Test	Yes	No	No	No	
Italian (Padua et al. 2004) (261)	No	Yes	No	No	No	No	No	No	An undocumented translation already existed, and after forward-backward translation the resulting Italian questionnaire was quite similar to the undocumented version, and this undocumented version was then chosen for validation.
Korean (Kim et al. 2013) (262)	No	Yes	No	Yes	Yes	Yes	No	No	
Persian (Ebrahimzadeh et al. 2015c) (263)	No	Yes	No	Test	Yes	No	No	No	
Swedish (Grevnerts et al. 2017) (264)	No	Yes	No	Yes	Yes	Yes	No	No	
Thai (Lertwanich et al. 2008) (265)	No	Yes	No	Test	Yes	No	No	No	
Turkish (Celik et al. 2014) (266)	No	Yes	No	Yes	Yes	Yes	No	No	

K-SES
Knee Self-Efficacy Scale

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Dutch (van Lankveld et al. 2019) (267)	No	Yes, but not described in detail	No	Test	Yes	No	No	No	Unclear if translated from Swedish or English
English (Thomeé et al. 2006) (268)	?	?	?	?	?	?	?	?	The PROM was developed in Sweden with Swedish patients. There is no indication how the English wording has been

									translated and how the English version has been validated.
KOOS *Knee Injury and Osteoarthritis Outcome Score*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tested in	Cross-cultural DIF tested	Comments
Arabic (Almangoush et al. 2013) (269)	No	Yes	No	Yes	Yes	Yes	No	No	
Chinese (Cheung et al. 2016) (270)	No	Yes	No	Test	Yes	No	No	No	From English
Chinese (Huang et al. 2017) (256)	No	Yes	No	Test	Yes	No	No	No	From English
Chinese (Cheng et al. 2019) (271)	Not relevant	Not relevant	Not relevant	No	No	No	No	No	The Singapore-Chinese version was adapted to Hong Kong-Chinese by professional translators.
Danish (Comins et al. 2008) (272)	?	?	?	?	?	?	No	No?	The Danish translation is undocumented.
Dutch (de Groot et al. 2008) (273)	No	Yes	No	Test	Yes	No	No	No	From Swedish
English (Roos et al. 1998a) (274)	?	?	?	?	?	?	No	No	English translation undocumented.
French (Ornetti et al. 2008) (275)	No	Yes	No	Test	Yes	No	No	No	From English
Greek (Moutzouri et al. 2015) (276)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Italian (Monticone et al. 2012b) (277)	No	Yes, see note	No	Test	Yes	No	No		From English. Backwards translation was apparently done so it would resemble the original
Japanese (Nakamura et al. 2011) (278)	No	Yes	No	Test	Yes	No	No	No	From English

Malaysian (Zulkifli et al. 2017) (279)	No	Yes	No	Yes	Yes	Yes	Yes	No	From English
Persian (Salavati et al. 2008) (280)	No	Yes	No	Test	Yes	No	No	No	From English
Polish (Paradowski et al. 2013) (281)	No	Yes	No	Yes	Yes	Yes	No	No	From English AND Swedish
Portuguese (Goncalves et al. 2009) (282)	No	Yes	No	Test	Yes	No	No	No	From US-English
Saudi Arabic (Alfadhel et al. 2018) (283)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Singapore-English, Singapore-Chinese (Xie et al. 2006) (284)	No	Yes, see note	No	Test	Yes	yes	No	No	Translated to Singapore-Chinese. The backtranslation to English was apparently different from the original English version and was termed Singapore-English
Spanish (Vaquero et al. 2014) (285)	No	Yes, see note	No	Test	Yes	No	No	No	Frem English
Swedish (Roos et al. 1998a) (274)	No	No	Yes, see note	No	No	No	No	No	The Original Swedish version was translated into English (developed simultaneously) and compared by a panel
Urdu, India (Ateef et al. 2017) (286)	No	No	Yes, see note	Test	Yes	No	No	No	From English, translated by a bureau, no backward translation
KOOS modified PROMs									
Japanese (Lyman et al. 2018) (287) *8-item short form*	Not relevant	Not relevant	Not relevant	Yes	Yes	Yes	No	No	This was re-deelopment of the ADL domain to fit Japanese culture plus addition of a Flexion domain
Malaysian (Zulkifli et al. 2017) (279) *5 domains, 26 item short form*	No	Yes	No	Yes	Yes	Yes	Yes	No	From English
Turkish (Gul et al. 2013) (288)	No	Yes	No	Test	Yes	No	No	No	

Physical Function short form									

KOOS-child
Knee Injury and Osteoarthritis Outcome Score for Children

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Dutch (van der Velden et al. 2019) (289)	No	Yes	No	Test	Yes	No	No	No	
French (Trottier et al. 2018) (290)	No	Yes	No	No	No	No	No	No	From English

It is unclear how the English version of KOOS-Child was developed.

KOOS4
Knee Injury and Osteoarthritis Outcome Score

No accessible studies found.

KOS
Knee Outcome Survey Activities of Daily Living Scale

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Arabic (Algarni et al. 2017) (291)	No	Yes	No	Yes	Yes	Yes	Yes	No	
Arabic (Bouzubar et al. 2018) (292)	No	Yes	No	Yes	Yes	No	No	No	
Chinese (Jia et al. 2016) (293)	No	Yes	No	Test	Yes	No	No	No	
French (Roy et al. 2014) (294)	No	Yes	No	Test	Yes	No	No	No	

German (Bizzini, Gorelick, 2007) (295)	No	Yes	No	Yes	Yes	Yes	No	No	
Greek (Kapreli et al. 2011) (296)	No	Yes	No	Yes	Yes	No	No	No	
Polish (Szczepanik et al. 2018) (297)	No	Yes	No	Yes	Yes	Yes	No	No	
Portuguese (Goncalves et al. 2008) (298)	No	Yes	No	Test	Yes	No	No	No	
Turkish (Evcik et al. 2009) (299)	No	Yes	No	Yes	Yes	Yes	No	No	
KSS *Knee Society Clinical Rating System*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Silva et al. 2012) (300)	No	Yes	No	Yes	Yes	Yes	No	No	
Spanish (Ares et al. 2013) (301)	No	Yes	No	Yes	Yes	Yes	No	No	
NEW VERSION OF KSS BELOW									
Brazilian-Portuguese (e Silvaa et al 2017) (302)	No	Yes	No	Test	Yes	No	No	No	
Dutch (van der Straeten 2013) (303)	No	Yes	No	Test	Yes	No	No	No	

Dutch (Dinjens et al 2014) (304)	No	No	Yes, see note	No	No	No	No	No	Adaption of KSS to the new generations, meaning extra activities were added. Translation is not described, but was probably made by the authors
French (Debettea et al 2014) (305)	Not documented	Not documented	Not documented	No	No	No	No	No	Apparently, authors did the translations but in no structured way
German (Kayaalp et al 2019) (306)	No	Yes	No	Yes	Yes	Yes	No	No	
Japanese (Hamamito et al 2015) (307)	No	Yes	No	No	No	No	No	No	
Korean (Kim et al 2017) (308)	No	Yes	No	Test	Yes	No	No	No	
Turkish (Ozden et al 2019) (309)	No	Yes	No	No	No	No	No	No	

2011 KSS - New version of Knee Society Score (See note above)

Kujala/AKPS
Anterior Knee Pain Score

The Questionnaire was developed with Finish patients. There is no description of how items were translated into English and how the translation was validated.

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Arabic (Hamdan et al. 2019) (310)	No	No	Yes, direct translation	No	No	No	No	No	?
Brazilian-Portuguese (da Cunha et al. 2013) (311)	No	Yes	No	Tesr	Yes	No	No	No	From English
Dutch (Kievit et al. 2013) (312)	No	Yes	No	Test	Yes	No	No	No	From English

Dutch (Ummels et al. 2017) (313)	No	Yes	No	No	No	No	No	No	From English
French (Buckinx et al. 2017) (314)	No	Yes	No	Test	Yes	No	No	No	From English
German (Dammerer et al. 2018) (315)	No	Yes	No	Test	Yes	No	No	No	From English
Greek (Papadoupoulos et al. 2017) (316)	No	Yes	No	Test	Yes	No	No	No	From English
Italian (Cerciello et al. 2018) (317)	No	Yes	No	No	No	No	No	No	From English
Spanish (Gil-Gámez et al. 2016) (318)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Thai (Apivatgaroon et al. 2016) (319)	No	Yes	No	Test	Yes	No	No	No	From English

Lysholm/LKS
Lysholm Knee Scoring Scale

Lysholm was developed by Swedish patients but reported in English. It is unknown how translation was performed and validated.

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Arabic (Ahmed et al. 2019) (253)	No	Yes	No	No	No	No	No	No	From English
Brazilian-Portuguese (Peccin et al. 2006) (320)	Undocumented	Undocumented	Undocumented	Yes	Yes	Yes	No	No	Undocumented
Chinese (Wang et al. 2016) (321)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Dutch (Eshuis et al. 2016) (322)	No	Yes	No	Test	Yes	No	No	No	From English

German (Swanenburg et al. 2014b) (323)	?	?	?	?	?	?	No	No	Translation undocumented
Spanish (Arroyo-Morales et al. 2019) (324)	Undocumented	Undocumented	Undocumented	No	No	No	No	No	
Turkish (Celik et al. 2013) (325)	No	Yes	No	Test	Yes	No	No	No	From English

PEDI-IKDC
Pediatric International Knee Documentation Committee

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Danish (Jacobsen et al. 2016) (326)	No	Yes	No	Yes	Yes	Yes	No	No	
Dutch (van der Velden et al. 2019) (289)	No	Yes	No	Test	Yes	No	No	No	

VISA-P
Victorian Institute of Sports Assessment – Patella

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Dutch (Zwerver et al. 2009) (327)	No	Yes	No	Test	Yes	No	No	No	
French (Kaux et al. 2016b) (328)	No	Yes	No	Test	?	No	No	No	
German (Lohrer et al. 2011) (329)	No	Yes	No	Test	No	No	No	No	

Greek (Korakakis et al. 2014) (330)	No	Yes	No	Yes	No	Yes	No	No	
Italian (Maffulli et al. 2008a) (331)	No	Yes, but only one forward and one backward translator	No	No	No	No	No	No	
Kannada, Indian (Acharya et al. 2018) (332)	No	Yes	No	Test	Yes	No	No	No	
Spanish (Hernández-Sanchez et al. 2011) (333)	No	Yes	No	Test	Yes	No	No	No	
Swedish (Frohm et al. 2004) (334)	No	Yes	No	Test	Yes	No	No	No	

WOMAC
Western Ontario and McMaster Universities Osteoarthritis Index

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tested in	Cross-cultural DIF tested	Comments
Arabic (Guermazi et al. 2004) (335)	No	Yes	No	Yes	Yes	Yes	No	No	
Arabic (Faik et al. 2008) (336)	No	Yes	No	Test	Yes	No	No	No	
Bengali (Rabbani et al. 2015) (337)	No	Yes	No	Yes	Yes	Yes	No	No	
Chinese (Xie et al. 2008) (338)	No	Yes	No	Yes	Yes	Yes	No	No	
Chinese (Symonds et al. 2015) (339)	No	Yes	No	Yes	Yes	Yes	No	No	
Finnish	?	?	?	?	?	?	No	No	There is no reference to a documented Finnish translation

(Soininen et al. 2008) (222)									
Hebrew (Wigler et al. 1999) (340)	No	No	Yes, apparently one translator each way	No	No	No	No	No	
Korean (Bae et al. 2001) (341)	No	Yes	No	No	No	No	No	No	
Persian (Nadrian et al. 2012) (224)	No	Yes	No	Test	Yes	No	No	No	
Persian (Ebrahimzadeh et al. 2014) (342)	No	Yes	No	No	No	No	No	No	
WOMAC modified PROMs									
Arabic (Alghadir et al. 2016) (343)	No	Yes	No	Test	Yes	No	No	No	
Nepalese (Nakarmi et al 2019) (344)	No	Yes, but only one translator each way	No	Yes	Yes	Yes	No	No	
Thai (Kuptniratsaikul et al. 2017) (345)	No	Yes, but only one translator each way	No	Test	Yes	No	No	No	

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Tabel 7: Translation, adaption and validation of knee PROMs.

Calf PROMs translation

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
LLFI *Lower Limb Functional Index*									
Spanish (Cuesta-Vargas et al. 2014) (346)	No	Yes	No	No	No	No	No	No	
Turkish (Duruturk et al. 2015) (347)	No	Yes	No	Test	Yes	No	No	No	
MTSS-score *Medial Tibial Stress Syndrome Score*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
English (Winters et al. 2016) (348)	No	Yes	No	No	No	No	No	No	

346. Cuesta-Vargas AI, Gabel CP, Bennett P. Cross cultural adaptation and validation of a Spanish version of the Lower Limb Functional Index. Health Qual Life Outcomes. 2014;12:75.
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Tabel 8: Translation, adaption and validation of calf PROMs.

Ankle PROMs translation

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
AAOS-FAOQ *American Academy of Orthopaedic Surgeons Foot and Ankle Outcomes Questionnaire*									
Korean (Kim et al. 2015) (349)	No	Yes	No	Yes	Yes	Yes	No	No	
Spanish (González-Sánchez et al. 2016) (350)	No	Yes	No	No	No	No	No	No	
Spanish (Zelle et al. 2017) (351)	No	Yes	No	Yes	Yes	Yes	No	No	
AOFAS-AHS *American Orthopaedic Foot & Ankle Society Hindfoot Score*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Rodrigues et al. 2008) (352)	No	Yes	No	Test	Yes	No	No	No	
Dutch (Boer et al. 2017a) (353)	No	Yes	No	No	Yes	No	No	No	
German (Kostuj et al. 2014) (354)	No	Yes	No	No	Yes	Yes	No	No	
Italian (Leigheb et al. 2016) (355)	No	Yes	No	Test	Yes	No	No	No	
Persian (Sayyed-Hossainian et al. 2018) (356)	No	Yes	No	Test	Yes	Yes	No	No	
Persian	No	Yes	No	Test	Yes	No	No	No	

(Vosoughi et al. 2018) (357)									
Turkish (Akbaba et al. 2016) (358)	No	Yes	No	Yes	Yes	Yes	No	No	

AOS *Ankle Osteoarthritis Scale*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Canadian-French (Angers et al. 2016) (358)	No	Yes	No	Yes	No	Yes	No	No	

ATRS *The Achilles Tendon Total Rupture Score*									
	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Zambelli et al. 2016) (359)	No	Yes	No	Yes	Yes	Yes	No	No	From English !
Chinese (Cui et al. 2017) (360)	No	Yes	No	Unerta in	Yes	Unc ertai n	No	No	From Englsh !
Danish (Ganestam et al. 2013) (361)	No	Yes	No	No	No	No	No	No	From Swedish
Dutch (Opdam et al. 2016) (362)	No	Yes	No	Yes	No	Yes	No	No	From English !
English (Carmont et al 2013) (363)	No	No	Yes	No	No	No	No	No	The wording of the undocumented English translation was changed by the researchers
French	No	Yes	No	Test	Yes	No	No	No	From English !

(Buckinx et al. 2019) (364)									
Greek (Touzopoulos et al. 2017) (365)	No	Yes	No	Test	Yes	No	No	No	From English !
Italian (Vascellari et al. 2016) (366)	No	Yes	No	No	Yes	No	No	No	From English !
Norwegian (Myhrvold et al. 2017) (367)	No	Yes	No	No	No	No	No	No	From Swedish
Persian (Ansari et al. 2016) (368)	No	Yes	No	Yes	Yes	Yes	No	No	From English !
Polish (Bakowski et al. 2017) (369)	No	Yes	No	Test	Yes	No	No	No	From English !
Sweden (Nilsson-Helander et al. 2007) (370)	?	?	?	?	?	?	No	No	The English version is undocumented
Turkish (Mutlu et al. 2005) (371)	No	Yes	No	Yes	Yes	Yes	No	No	From Swedish

FAAM
Foot and Ankle Ability Measure

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Moreira et al. 2016) (372)	Yes	No	Yes	Yes	Yes	Yes	No		Yes
Chinese (González-Sancéz et al. 2016) (373)	Yes	No	Test	Yes	Yes	No	No		Yes
Dutch (Weel et al. 2016) (374)	Yes	No	Test	No	Yes	No	No		Yes
French	No	Yes	No	Test	Yes	Yes	No	No	

(Borloz et al. 2011) (375)									
German (Nauck, Lohrer, 2009) (376)	No	Yes	No	Yes	No	Yes	No	No	
Japanese (Uematsu et al. 2015) (377)	No	Yes	No	Yes	No	Yes	No	No	
Spanish (Cervera-Garvi et al. 2017) (378)	No	Yes	No	Yes	Yes	Yes	Yes	No	
Thai (Arunakul et al. 2015) (379)	No	Yes	No	No	No	No	No	No	
Turkish (Celik et al. 2016) (380)	No	Yes	No	Yes	Yes	Yes	No	No	

FAOS
Foot & Ankle Outcome Score

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Imoto et al. 2009) (381)	No	Yes	No	Test	Yes	Yes	No	No	From English
Chinese (Ling et al. 2018) (382)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Danish (Larsen et al. 2017) (383)	No	Yes	No	Yes	Yes	Yes	No	No	From Swedish
Dutch (van den Akker-Scheek et al. 2013) (384)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Dutch (Sierevelt et al. 2015) (385)	No	Yes	No	Test	Yes	No	Yes	No	From English

English (Chen et al. 2012) (386)	?	?	?	?	?	?	No	No	There is no documented English translation
German (van Bergen et al. 2014) (387)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Korean (Lee et al. 2013) (388)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Persian (Negahban et al. 2010) (389)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Spanish (Pellegrini et al. 2019) (390)	No	Yes	No	Yes	Yes	Yes	No	No	From English
Swedish (Roos et al. 2001) (391)	?	?	?	?	?	?	No	No	No documented translation to English
Thai (Angthong, 2016) (392)	No	Yes	No	No	No	No	No	No	From English
Turkish (Karatepe et al. 2009) (393)	No	Yes	No	Test	Yes	Yes	No	No	From English

FFI
Foot Function Index

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (Yi et al. 2015) (394)	No	Yes	No	Yes	Yes	Yes	No	No	
Brazilian-Portuguese (Yi et al. 2017) (395)	No	Yes	No	Yes	Yes	Yes	No	No	
Chinese (Gonzáles-Sanchéz et al. 2017) (396)	No	Yes	No	Unclea r	Yes	Uncl ear	No	No	
French	No	Yes	No	Test	Yes	Yes	No	No	

(Pourtier-Piotte et al. 2015) (397)									
Italian (Vetrano et al. 2014) (398)	No	Yes	No	Test	No	No	No	No	
Persian (Mousavian et al. 2019) (399)	No	Yes	No	No	No	No	No	No	
Spanish (Pod et al. 2013) (400)	No	Yes	No	Test	Yes	Yes	Yes	No	
Thai (Srimakarat et al. 2018) (401)	No	Yes	No	Yes	Yes	Yes	No	No	
FFI modified PROMs									
Brazilian-Portuguese (Stéfani et al. 2017) (402) *FFI-R 68-item scale*	No	Yes	No	Test	Yes	No	No	No	
Chinese/Taiwan (Wu et al. 2008) (403) *Modified 21-item scale*	No	Yes	No	No	No	No	No	No	
German (Naal et al. 2008b) (404) *Modified 18-item scale*	No	Yes	Yes	Yes	Yes	Yes	No	No	
Italian (Martinelli et al. 2014) (405) *Modified 18-item scale*	No	Yes	No	Yes	Yes	Yes	No	No	
Italian (Venditto et al. 2015) (406) *Modified 17-item scale*	No	Yes	No	Yes	Yes	Yes	No	No	
Korean (Huh et al. 2016) (407)	No	Yes	No	Yes	Yes	Yes	No	No	

Modified 18-item scale									
Polish (Rutkowski et al. 2017) (408) *FFI-R 34-item scale*	No	Yes	No	Test	Yes	No	No	No	
Turkish (Yagci et al. 2019) (409)	No	Yes	No	Yes	Yes	Yes	No	No	

VISA-A
Victorian Institute of Sports Assessment-Achilles

	Dual panel translation	Forward-backwards translation	Other methods of translation	Cognitive interviews	Tested in relevant patient groups	Modifications (cultural	Dimensionality tsted in	Cross-cultural DIF tested	Comments
Brazilian-Portuguese (de Mesquita et al. 2018) (410)	No	Yes	No	Yes	No	Yes	No	No	Delphi decision among Brazilian physioptherapists regarding wording
Chilean-Spanish (Keller et al. 2018) (411)	No	Yes	No	Yes	Yes	Yes	No	No	
Danish (Iversen et al. 2016) (412)	No	Yes	No	Yes	No	Yes	No	No	
Dutch (Sierevelt et al. 2018) (413)	No	Yes	No	No	No	No	No	No	
French (Kaux et al. 2016c) (414)	No	Yes	No	Yes	Yes	Yes	No	No	
German (Lohrer, Nauck, 2009) (415)	No	Yes	No	Yes	Yes	Yes	No	No	
Italian (Maffulli et al. 2008b) (416)	No	Yes,one translator each way	No	No	No	No	No	No	
Spanish	No	Yes	No	Yes	Yes	Yes	Yes	No	

(Hernández-Sanchez et al. 2017) (417)									
Swedish (Silbernagel et al. 2005) (418)	No	Yes	No	Yes	Yes	Yes	No	No	
Turkish (Dogramaci et al. 2009) (419)	No	Yes	No	Yes	Yes	Yes	No	No	

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Tabel 9: Translation, adaption and validation of ankle PROMs.