Cross-cultural translation and validation of the Chinese Oxford Knee Score and the Activity and Participation Questionnaire

Cheng Chen¹,², Weijun Wang¹,³, Hao Wu¹, Anqi Gao², Yong Qiu¹, Wenjie Weng¹ and Andrew Price³

Abstract
Objective: To cross-culturally translate and validate the Chinese versions of the Oxford Knee Score (OKS) and the Activity and Participation Questionnaire (APQ) in patients with end-stage knee osteoarthritis who are also candidates for knee replacement. Methods: The Chinese version of the OKS and APQ was completed by standard forward–backward translation and adaption. The feasibility was validated by a pretest in 30 patients. The final version together with the Short Form-36 (SF-36), EQ-5D, and EQ visual analog scale were assessed in 150 patients, and the OKS and APQ were repeated in 30 patients after a 2-week interval. The psychometric properties of the OKS and APQ were evaluated for test–retest reliability using intraclass correlation coefficients (ICCs), internal consistency using Cronbach’s $\alpha$, and construct validity using Spearman’s correlation analysis. Results: All patients were able to understand and complete both the OKS and APQ without difficulty (i.e. no missing data). The ICCs were 0.959 for the OKS, 0.956 for the APQ for total scores, and >0.7 for each item. Cronbach’s $\alpha$ was greater than 0.7, and the corrected item-total correlation was greater than 0.4 for each item of both questionnaires. The OKS and APQ showed better correlations with questions from the pain and function domains than with those from the mental status domains of the SF-36 and EQ-5D. No floor or ceiling effect was identified in either questionnaire. Conclusions: The Chinese versions of the OKS and APQ are easy to understand and complete and showed good reliability and validity. They can be used to assess patient-reported outcomes after undergoing knee replacement in mainland China.

Keywords
Activity and Participation, knee osteoarthritis, Oxford Knee Scores, patient-reported outcome, translation and validation

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Introduction
Patient-reported outcomes (PROs) have been recognized as an important part of outcome assessment in orthopedic treatment in addition to traditional radiographic and clinical tests. Several health-related quality of life (HRQoL) instruments, both generic and disease-specific, have been developed in the past few decades.¹⁻⁴ Knee osteoarthritis (OA) is one of the most common degenerative disorders in aging populations, resulting in pain, functional disability, and significantly reduced quality of life.⁵ Knee replacement, either total or partial, has been shown to be an effective treatment for knee OA.
effective treatment for end-stage knee OA with a good long-term prosthesis survival rate. Several knee OA-specific patient-reported outcome measurements (PROMs) were developed to assess PROs of knee replacement, including the American Knee Society Score, Knee Injury and Osteoarthritis Outcome Score, and Oxford Knee Score (OKS). The OKS is a 12-item, self-administered questionnaire used to assess the pain and function of patients undergoing knee replacement surgery. The questionnaire is short, simple, inexpensive, reliable, valid, and responsive. It has been proven by Rasch analysis to be a valid scale that is largely free of bias and is considered the only knee-specific PROM with a high level of scrutiny in patients who have received knee replacement surgery. Since April 2009, the OKS has been adopted by the National Health Service PROMs program in England and Wales as a primary outcome measure for knee replacement surgery. Moreover, the OKS can be used to predict the American Knee Society Score and to identify patients who require clinical assessment within 2 years after total knee arthroplasty (TKA). Additionally, preoperative and postoperative OKSs have been shown to be prognostic factors for post-TKA function and outcome. Nevertheless, some studies have shown that application of the OKS can be extended to patients undergoing nonoperative management for knee OA in a clinical setting. Since it was developed and published in 1998, the OKS has been translated and cross-culturally adapted into more than 10 languages, including Singapore Chinese, and has shown good psychometric properties by validation. As all we know, there is only one study of Chinese version OKS validated for knee OA patients in mainland China, we translated and adapted the Chinese versions of the OKS and APQ and validated them, specifically in terms of feasibility, reliability, and construct validity, in patients with end-stage knee OA who were candidates for knee arthroplasty.

Materials and methods

The study was approved by the hospital clinical research ethics committee, and permission was granted from Isis Innovation Ltd, the technology transfer company of the University of Oxford. The guidelines for cross-cultural adaptation of HRQoL measures were followed. The original English versions of the OKS and APQ were forward-translated by one professional standard translator and one orthopedic surgeon experienced in the diagnosis and treatment of knee OA, both of whom are native Chinese speakers. Discrepancies regarding the translated Chinese versions were discussed with three other Chinese orthopedic surgeons to achieve a consensus. The Chinese versions were then backward-translated into English by two nonmedical native English speakers. The backward-translated English versions were compared with the resource versions in a panel discussion. Once language equivalency was achieved, the pre-final Chinese versions of the OKS and APQ were sent to 30 patients with end-stage knee OA for a pretest. At the end of the test, the patients were asked whether they experienced difficulties in understanding and answering the questionnaires, whether any important issues related to knee OA were not presented in the questionnaires and whether they had any further comments. The integrity of the questionnaires was inspected. Reasons for any missing items were investigated. Missing data due to difficulties in understanding or answering questions were recorded. Further refinement was conducted according to the pretest results by panel discussion.

Validation

Patients. Patients with end-stage primary unilateral knee OA who were candidates for knee replacement were recruited. Patients who met any of the following criteria were excluded: (1) disorders in other joints or deformity of the lower limbs; (2) neurological dysfunction in the lower limbs or other disabling conditions; (3) low back pain; and (4) inability to read and/or write. Since 5 to 20 samples would be recommended for each item in questionnaire
validation, and there are 12 items in the OKS and 8 items in the APQ, the expected sample size should be greater than 100. The consent form was approved by the hospital ethical committee and was completed by all participants before they answered the questionnaires. Another form was used to collect demographic information, including age, gender, education level, residence, knee involvement, body weight, and height.

Questionnaires. The participants were asked to answer a package of questionnaires, including the OKS, APQ, Short Form-36 (SF-36), EQ-5D, and EQ visual analog scale (EQ VAS) for knee pain. In addition, the patients who needed time to settle their affairs before undergoing knee replacement were invited to retake the OKS and APQ after a 2-week interval. Copies of the OKS and APQ were provided to these patients by the clinic in a stamped envelope. Two weeks later, the patients were reminded via telephone to complete the questionnaires and send them back in the stamped envelope. Thirty patients were recruited for the test–retest analysis.

The OKS consists of 12 items on two subscales addressing perception of pain and function, and the APQ consists of 8 items with a single dimension, each with 5 possible responses on a Likert-type scale. Although the original version of the OKS was designed for scores of 1 to 5 points, it was later modified for scores from 0 (worst) to 4 (best) points, which was also applied to the APQ. Summary scores ranged from 0 (worst) to 48 (best) for the OKS and from 0 (worst) to 32 (best) for the APQ.

The SF-36, EQ-5D, and VAS were completed by patients to test the construct validity of the translated OKS and APQ. The SF-36 is one of the most commonly used generic HRQoL instruments, containing 36 items and measuring 8 domains: physical functioning, role physical, bodily pain, general health, vitality, social functioning, role emotional, and mental health. These domains can be divided into a physical component summary and mental component summary. The EQ-5D includes five items describing mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. The EQ VAS was used to evaluate pain in the knee affected by OA. The Chinese versions of these HRQoL assessments have been validated previously.

Data analysis. SPSS version 21.0 (SPSS Inc, Chicago, Illinois, USA) was used for the statistical analyses. The reliability of the translated OKS and APQ was measured using intraclass correlation coefficients (ICCs) for agreement. ICCs were calculated between the responses of the first (test) and the second (retest) questionnaire for each item and between total OKS and APQ scores. Excellent agreement was defined as an ICC ≥ 0.70.

The internal consistency of the OKS and APQ was assessed by Cronbach’s z, and the effect of removing any single item on the z was examined in both questionnaires. A value of Cronbach’s z between 0.70 and 0.90 was regarded as an acceptable correlation, and a value ≥0.90 was considered excellent for individual comparisons, but in group comparisons, this value may indicate redundancy of the items. A corrected item-total correlation ≥0.40 was considered acceptable for each item.

Construct validity was examined by analyzing correlations between responses on the translated OKS and APQ and the results of the SF-36, EQ-5D, and EQ VAS using Spearman’s correlation coefficients. To examine the convergent construct validity, we hypothesized moderate (>0.35) to strong correlations (>0.50) between the OKS/APQ and the SF-36 subscales of physical functioning, role physical, body pain and social functioning, the EQ-5D subscales of usual activities and pain/discomfort, and the EQ VAS. For divergent construct validity, which states that an item should not correlate strongly (<0.5) with any other items measuring a different construct, weak correlations (<0.35) between the OKS and the SF-36 mental health and role emotional domains and the EQ-5D anxiety/depression domain were expected.

Floor and ceiling effects were analyzed by calculating the proportions of scores. Since a higher score indicated a worse functional outcome, the floor effect was defined by the proportion of the highest score (4 for a single item, 48 for the total OKS, and 32 for the total APQ), while the ceiling effect was defined by the proportion of the lowest (0) score. If a measure has >15% of participants achieving top or bottom score, this is indicative of a ceiling/floor effect.

Results

Translation and adaptation

The backward-translated English versions of the OKS and APQ showed equivalent meaning to the original version, suggesting that both the forward- and backward-translations were accurate and language-equivalent. The Chinese version was pretested in 30 patients (18 females and 12 males), including 19 rural and 11 urban residents. The education levels of these patients varied from primary school to university education. No assistance was requested, and none of the patients reported difficulty in understanding and answering the questions. No missing data were observed in the questionnaires. The patients agreed that the questionnaires adequately represented problems related to the affected knee and did not offer any suggestions for further improvement. Therefore, the final Chinese versions of the OKS and APQ (see Online Appendix) were used for validation.

Validation

An additional 150 patients were recruited to complete the questionnaire package for OKS and APQ validation, including 55 males and 125 females with a mean age of
63.7 years (range, 58–79 years). The patients were either urban or rural inhabitants with varied education levels. Patients demographics data were shown Table 1. Since the integrity of the questionnaires was assessed routinely upon collection from the patients, no missing data were observed.

Thirty patients retook the OKS and APQ at a mean interval of 14 days. The mean scores of the OKS in the test and retest phases were 22.5 ± 10.5 and 22.2 ± 11.2, and the mean scores of the APQ were 10.0 ± 7.3 and 10.1 ± 6.5, respectively. Both the OKS and APQ showed excellent reliability with ICCs of 0.959 and 0.939 overall, respectively, and an ICC of >0.7 for each item (Table 2).

The internal consistency was good in both questionnaires, with Cronbach’s α values of 0.939 for the OKS and 0.901 for the APQ. Removal of any single item in the questionnaires did not result in a significant decrease in the overall Cronbach’s α value (Table 2). Corrected item-total correlations were greater than 0.4 for all items, suggesting no overlapping of the measurements for each item.

A ceiling effect (worst score) was observed for items 1, 4, 6, and 7 of the OKS and for all items of the APQ, while a floor effect (best effect) was found for items 8 and 10 of the OKS but no items in the APQ. However, no floor effect was observed for either questionnaire at the scale level. Two patients (1.1%) reported the worst possible score for the OKS, while 22 patients (12.2%) had the worst possible score for the APQ, both showing no ceiling effect.

The construct validity of the OKS and APQ was tested using the EQ-5D, EQ VAS, and SF-36, and the results are presented in Table 3. The OKS showed strong correlations with the usual activities and pain/discomfort items of the EQ-5D, the physical function, back pain, energy/vitality, and social function domains of the SF-36, and the EQ VAS. The APQ showed a strong correlation with the physical function domain of the SF-36 and moderate correlations with the usual activities item of the EQ-5D and all domains except for the role emotional domain of the SF-36. The APQ showed weak correlations with the mobility, self-care, pain/discomfort, and anxiety/depression domains of

| Characteristics | Numerical value |
|-----------------|-----------------|
| Age (years)     | 63.7 (58–79)    |
| Gender (male/female) | 125/55          |
| BMI (kg/m²)     | 25.5 (17.6–33.3) |
| Years of education (%) |                  |
| <6              | 107 (59.4)      |
| 7–9             | 56 (31.1)       |
| >9              | 17 (9.4)        |
| Living area (%) |                 |
| Urban           | 61 (33.9)       |
| Rural           | 119 (66.1)      |

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Table 2. Test–retest reliability, floor and ceiling effects, and the internal consistency of the Chinese versions of the OKS and APQ.

|          | Mean ± SD | Test–retest reliability (n = 30) | Floor effect (%) | Ceiling effect (%) | Item-total correlation | Cronbach’s α if item deleted |
|----------|-----------|----------------------------------|------------------|--------------------|------------------------|------------------------------|
| OKS      |           |                                  |                  |                    |                        |                              |
| OKS1     | 0.7 ± 0.8 | 0.877***                         | 1.1              | 47.8               | 0.702                  | 0.763                        |
| OKS2     | 2.1 ± 1.0 | 0.891***                         | 8.9              | 5.0                | 0.764                  | 0.758                        |
| OKS3     | 1.9 ± 0.9 | 0.855**                          | 6.7              | 3.3                | 0.838                  | 0.757                        |
| OKS4     | 1.6 ± 1.2 | 0.769**                          | 7.8              | 19.4               | 0.657                  | 0.757                        |
| OKS5     | 1.9 ± 0.9 | 0.890**                          | 5.6              | 6.1                | 0.732                  | 0.760                        |
| OKS6     | 1.8 ± 1.2 | 0.961**                          | 10.0             | 16.7               | 0.762                  | 0.753                        |
| OKS7     | 1.2 ± 1.0 | 0.821**                          | 1.1              | 34.3               | 0.813                  | 0.756                        |
| OKS8     | 2.1 ± 1.3 | 0.967**                          | 23.9             | 11.1               | 0.751                  | 0.751                        |
| OKS9     | 1.8 ± 1.1 | 0.843**                          | 2.2              | 13.9               | 0.843                  | 0.754                        |
| OKS10    | 2.5 ± 1.2 | 0.968**                          | 17.8             | 7.2                | 0.690                  | 0.757                        |
| OKS11    | 2 ± 1.2   | 0.820**                          | 13.3             | 13.9               | 0.781                  | 0.753                        |
| OKS12    | 1.8 ± 1.0 | 0.882**                          | 8.3              | 5.0                | 0.776                  | 0.757                        |
| OKS-TOTAL| 21.4 ± 10.1|                                 | 0                | 1.1                |                         | 0.939                        |
| APQ      |           |                                  |                  |                    |                        |                              |
| APQ1     | 0.5 ± 0.7 | 0.765***                         | 2.2              | 55.0               | 0.537                  | 0.779                        |
| APQ2     | 0.8 ± 0.9 | 0.640**                          | 7.8              | 47.2               | 0.679                  | 0.766                        |
| APQ3     | 0.9 ± 0.9 | 0.895**                          | 2.2              | 37.8               | 0.720                  | 0.765                        |
| APQ4     | 1.3 ± 1.3 | 0.916**                          | 5.0              | 34.4               | 0.833                  | 0.745                        |
| APQ5     | 1.2 ± 1.1 | 0.846**                          | 4.4              | 34.4               | 0.730                  | 0.756                        |
| APQ6     | 1.2 ± 1.2 | 0.907**                          | 8.3              | 30.6               | 0.834                  | 0.748                        |
| APQ7     | 1.3 ± 1.1 | 0.760**                          | 5.6              | 28.9               | 0.714                  | 0.758                        |
| APQ8     | 1.2 ± 1.2 | 0.841**                          | 5.6              | 33.9               | 0.809                  | 0.751                        |
| APQ-TOTAL| 8.3 ± 6.6 |                                  | 0                | 12.2               |                         | 0.901                        |

OKS: Oxford Knee Score; APQ: Activity and Participation Questionnaire; SD: standard deviation.

*180 points for the latest versions of the OKS and APQ. Thirty patients repeated the questionnaire after a two-week interval.

**Excellent reliability with ICC of >0.7.
Table 3. Construct validity of the Chinese versions of the OKS and APQ.*

|          | OKS     | APQ     |
|----------|---------|---------|
| EQ-5D    |         |         |
| Mobility | -0.417*** | -0.257** |
| Self-care| -0.421*** | -0.288*** |
| Usual activities | -0.578*** | -0.446*** |
| Pain/Discomfort | -0.513*** | -0.318*** |
| Anxiety/Depression | -0.443*** | -0.311*** |
| VAS      |         |         |
| Physical function | 0.677*** | 0.532*** |
| Role physical | 0.451*** | 0.367*** |
| Back pain | 0.680*** | 0.366*** |
| General health | 0.406*** | 0.387*** |
| Role emotional | 0.347*** | 0.277*** |
| Energy/Vitality | 0.509*** | 0.437*** |
| Mental health | 0.319*** | 0.441*** |
| Social functioning | 0.529*** | 0.463*** |
| SF-36 components |         |         |
| PCS      | 0.712*** | 0.562*** |
| PCS      | 0.508*** | 0.489*** |

OKS: Oxford Knee Score; APQ: Activity and Participation Questionnaire; VAS: visual analog scale; SF-36: Short Form-36; PCA: physical component summary; MCS: mental component summary.

*p < 0.01; **p < 0.001.

The Chinese versions of the OKS and APQ were translated and validated in patients with end-stage knee OA who were candidates for knee replacement in mainland China. None of the items in the original forms of both questionnaires caused any problems in the translation process, and no differences between our version and the Singapore Chinese version of the OKS. Interestingly, when we validated our translated OKS-APQ in our center located in the east of China, Lin et al.35 validated a Simple Chinese version OKS in a center located in the south of China, and people there speak both Cantonese and Mandarin. The validated Simple Chinese version OKS from the present study is very similar as the one by Lin et al.35. Both the study by Lin et al.35 and the present study found high reliability and internal consistency of the translated simple Chinese version OKS without need of further modification, suggesting that the OKS can be used by patients in mainland China.

Due to improved long-term outcomes, the number of TKA procedures performed in young and active patients has increased in the past decade. To evaluate participation in social and recreational activities, including sports, Dawson et al.1 developed the APQ as a supplement to the OKS to provide a more comprehensive PROM. Similar to the OKS, the development of the APQ was patient-oriented and involved careful interviews, and 8 items were ultimately selected and validated by standard methods. The unidimensional scale was found to be reliable, valid, and sensitive compared to the original version. The results of the present study showed APQ scores comparable to those of the original English version. In addition, the reliability, internal consistency, and construct validity were high for single items and for the overall scale. Construct validity analysis showed that the APQ is strongly correlated with the usual activities item of the EQ-5D and the physical function domain of the SF-36. In addition, it showed poor correlations with less relevant domains in the SF-36, such as pain and role emotion. Therefore, the APQ can be used to evaluate the activity levels of knee OA patients. Notably, according to the designers’ suggestion, the APQ should be used together with the OKS to provide a more comprehensive PROM but should not be used independently.1

We acknowledge several limitations of our study. First, the postoperative OKS and APQ results of the patients were not available at this stage, and responses on the two questionnaires cannot be tested with respect to knee replacement. Second, the patients in the present study mainly resided in the eastern part of China and included both urban and rural inhabitants with varied education levels. Eating habits and lifestyles vary between people from the eastern and western parts of China. Therefore, further validation of the Chinese versions of the OKS and APQ in other centers would be helpful. Moreover, some studies have shown that the OKS can be applied in patients with moderate knee OA,14,20,33 which will be validated in Chinese patients in our future study.

Discussion

The Chinese versions of the OKS and APQ were translated and validated in patients with end-stage knee OA who were candidates for knee replacement in mainland China. None of the items in the original forms of both questionnaires caused any problems in the translation process, and no further cultural adaption was required. The translated OKS and APQ showed good content validity, test–retest reliability, internal consistency, and construct validity compared to the original version1,2 and other language versions of the OKS.22–35,38,44

The OKS was developed and published in 1998 by Dawson et al.2 based on suggestions from patients rather than clinical assumptions proposed by clinical doctors. Because it is short, simple, and easy for patients to understand, the OKS has been widely used as a PROM of knee replacement and has been adopted by the National Health Service PROMs program in England and Wales.13,14 The questionnaire has been translated into more than 10 languages and has shown good psychometric properties through validation.22–35,38,44 Chinese versions of the OKS have been translated and validated in Singapore Chinese-speaking patients.27,35 However, Singapore is a country with a multi-ethnic population and four official languages. Although most Chinese-speaking people in Singapore emigrated from China, the culture and lifestyle are different, with Singapore having adopted a predominantly Western lifestyle. Therefore, a Chinese version validated in knee OA patients in Singapore may not be suitable for Mandarin-speaking patients in mainland China, which was confirmed by differences between our version and the Singapore Chinese version of the OKS. Interestingly, when we validated our translated OKS-APQ in our center located in the east of China, Lin et al.35 validated a Simple Chinese version OKS in a center located in the south of China, and people there speak both Cantonese and Mandarin. The validated Simple Chinese version OKS from the present study is very similar as the one by Lin et al.35. Both the study by Lin et al.35 and the present study found high reliability and internal consistency of the translated simple Chinese version OKS without need of further modification, suggesting that the OKS can be used by patients in mainland China.

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The EQ-5D, the EQ VAS, and the role emotional domain of the SF-36.

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The Oxford Knee Score (OKS) and Activity and Participation Questionnaire (APQ) were validated in patients with end-stage knee osteoarthritis (OA) in mainland China. The validated Chinese versions of the OKS and APQ showed good construct validity, test–retest reliability, internal consistency, and construct validity compared to the original versions. The EQ-5D, the EQ VAS, and the role emotional domain of the SF-36 showed strong correlations with the Chinese versions of the OKS and APQ. The EQ-5D and EQ VAS, compared to the original versions, were less sensitive. The APQ was strongly correlated with the usual activities item of the EQ-5D and the physical function domain of the SF-36. These findings suggest that the Chinese versions of the OKS and APQ can be used in patients with end-stage knee OA in mainland China.
Despite these limitations, two advantages of the present study should be highlighted. Involvement of the designers of the OKS and APQ in the translation process facilitated an accurate understanding of the fundamental meaning of each question, even though they are already easy to understand. In addition, both the OKS and APQ were translated and validated using the same process. Since the two questionnaires provide comprehensive assessments of PROs, translating and validating them together may have resulted in increased consistency between the two questionnaires compared to translating and validating them separately by different groups.

In conclusion, the Chinese versions of the OKS and APQ were translated and validated in patients in mainland China with end-stage knee OA who were considering knee replacement surgery. Both questionnaires were found to be equivalent to the original English versions and were easy to understand and complete by the patients. The Chinese versions of the OKS and APQ showed similar reliability and validity to the original version. Therefore, they are encouraged for assessing PROs in patients undergoing knee replacement in mainland China.

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ORCID ID
Cheng Chen https://orcid.org/0000-0002-7716-4228

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