Original Article

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# Cross-Cultural Adaptation, Reliability, and Validity Tests of the Thai Version of the Manchester-Oxford Foot Questionnaire in Individuals with Chronic Foot Pain

Poramut Kul-eung, PT, M.Sc., Praneet Pensri, PT, DPT, Ph.D.

Department of Physical Therapy, Faculty of Allied Health Sciences, Chulalongkorn University, Pathumwan, Bangkok 10330, Thailand.

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## Abstract:

**Objective:** To adapt cross-culturally and examine the reliability and validity of the Thai version of MOXFQ (Thai-MOXFQ) among individuals with chronic foot pain.

**Material and Methods:** The Thai-MOXFQ was successfully adapted cross-culturally from the original version with minor changes according to the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) guidelines. Its reliability and construct validity were then investigated in individuals with chronic foot pain. The test-retest reliability was evaluated among 30 participants by calculating the intraclass correlation coefficient (ICC 3,1). Meanwhile, the internal consistency of the Thai-MOXFQ was studied in 100 participants by computing Cronbach's alpha. Additionally, the construct validity was analyzed via Spearman's rank correlation analysis to determine the relationship between the Thai-MOXFQ, Foot and Ankle Ability Measure (FAAM), 36-item Short-Form Health Survey (SF-36), and Visual Analogue Scale (VAS).

**Results:** The Thai-MOXFQ demonstrated a good level of test-retest reliability (ICC of 0.763 to 0.885) and an acceptable level of internal consistency (Cronbach's alpha of 0.738 to 0.871) when used in individuals with chronic foot pain. Moreover, the Thai-MOXFQ was shown to have moderate to strong relationships with FAAM, SF-36, and VAS ($p$-value<0.05, Spearman rank correlation coefficients of 0.543 to 0.711). Furthermore, the results of the construct validity of the Thai version were in line with the original English and other translated versions.

**Conclusion:** The Thai-MOXFQ is a reliable and valid, foot-specific, patient-reported outcome measurement (PROM) for assessing outcomes in individuals with chronic foot pain.

**Contact:** Dr. Praneet Pensri, PT, DPT, Ph.D.
Department of Physical Therapy, Faculty of Allied Health Sciences,
Chulalongkorn University, Pathumwan, Bangkok 10330, Thailand.
E-mail: praneet.p@chula.ac.th

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## Introduction

Foot pain is an uncomfortable feeling that is related to tissue damage located below the tibia and fibula[1]. According to the International Association for the Study of Pain Classification of chronic pain for the International Classification of Diseases (ICD-11), if the pain persists or recurs for more than 3 months, it can be considered as "chronic pain"[2]. Therefore, this study defined chronic foot pain as an uncomfortable feeling that is related to tissue damage located below the tibia and fibula, which is persistent or recurrent for longer than 3 months[1,2].

Previous studies have stated that 10-24% of the population experience foot problems at least once[3,4], and that the prevalence of foot problems tends to be higher in females[5], the obese, and those aged over 45 years[6]. Foot problems are frequently associated with ankle joint limitation, loss of balance[7], risk of falling, and a decreased health-related quality of life[8]. Two studies involving Thai populations found that 9% and 13.4% of the study populations had foot problems[9,10].

A health-related questionnaire is a subjective measurement tool that provides a standardized measure for evaluating treatment outcomes from the respondent's perspective[11]. The biopsychosocial model is a multifactorial approach that can be used in evaluating a person affected by musculoskeletal problems[12]. In Thailand, three foot-specific questionnaires have been previously translated into Thai, namely the Foot and Ankle Ability Measure (FAAM)[13], the Foot and Ankle Outcome Scale (FAOS)[14], and the Foot Function Index[15]. The Manchester-Oxford Foot Questionnaire (MOXFQ) is a foot-specific patient-reported outcome measurement (PROM) initially designed for hallux valgus surgery outcome assessment[16], which has been subsequently validated for use in the assessment of musculoskeletal foot conditions[17-19]. In systematic reviews, the MOXFQ has been reported to demonstrate an acceptable level of overall psychometric properties, and it has been recommended for use in studies on participants with foot and ankle conditions[20]. The original version of MOXFQ has been translated into 10 languages: Italian[21], Persian[22], Spanish[23], Turkish[24], Dutch[25], German[26], Korean[27], French[28], Finnish[29], and Chinese[30]. Each translation process involved some cross-cultural adaptation to minimize errors resulting from cultural differences[31]. A previous systematic review of the measurement properties of PROMs reported that there was positive evidence for four properties of FAAM, i.e., reliability, measurement error, structural validity, and discriminant validity[20]. Meanwhile, there was negative evidence related to internal consistency and convergent validity. Regarding FAOS, there was positive evidence on three of its properties, namely structural validity, convergent validity, and discriminant validity; however, there was negative evidence on internal consistency, and conflicting evidence was reported on reliability. This review also indicated that the MOXFQ has the best positive evidence in terms of overall psychometric properties such as internal consistency, reliability, measurement error, structural validity, convergent validity, discriminant validity, and responsiveness. It is, thus, assumed that the MOXFQ is an appropriate tool with high-quality evidence for evaluating patients with foot and ankle diseases[20]. The existing Thai versions of three foot-specific questionnaires evaluate pain, symptoms, disability, and quality of life in individuals with foot problems[13-15]; however, they have no items relating to the social domain. The original MOXFQ contains 16 items enquiring about an individual's pain, walking/standing, and

social interaction domains; unfortunately, no Thai version of MOXFQ is available. Therefore, the purpose of this study was to adapt the MOXFQ cross-culturally from its original English version into a Thai version and to determine the test-retest reliability, internal consistency, and construct validity of the Thai-MOXFQ in participants with chronic foot problems.

## Material and Methods

This study was approved by the Research Ethics Review Committee for Research Involving Human Participants, Group 1, Chulalongkorn University (no. 199.1/62, 9 January 2020). All participants signed a consent form prior to participating in the study. This study was conducted in 2 parts; the first part involved the cross-cultural adaptation of the MOXFQ into the Thai version, and in the second part, the reliability and validity of the Thai-MOXFQ were examined in individuals with chronic foot pain.

### Cross-cultural adaptation

To perform the cross-cultural adaptation of the MOXFQ from its original English version into a Thai version, the researcher obtained permission from the developers and agreed to apply the International Society for Pharmacoeconomics and Outcomes Research (ISPOR) guidelines during the cross-cultural adaptation process[31]. There were 10 stages in the cross-cultural adaptation process: preparation, forward translation, reconciliation, back translation, back translation review, harmonization, cognitive debriefing, review of cognitive debriefing results, finalization, and proofreading. Five translators participated in the translation and proofreading processes; they consisted of an academic researcher from the Faculty of Allied Health Sciences, Chulalongkorn University, who served as an in-country consultant and the first forward translator; two lecturers from the Chulalongkorn University Language Institute (a native Thai-speaker for the forward translation and a native English-speaker for the backward translation); and a bilingual lecturer with an experience level of more than 5 years in Thai-English teaching and translation, who acted as the second backward translator. The back translators were blinded from the original version of MOXFQ. The first Thai version of MOXFQ was tested on 10 native Thai speakers with chronic foot pain prior to the proofreading process. The proofreader was a native Thai speaker with 3 years of Thai-English translation experience and was not related to the translation process.

### Participants

Participants were eligible for enrollment in this study if they were native Thai speakers, aged 18-60 years, reported foot problems with a pain intensity of more than 20 mm when assessed by the VAS (100 mm), and had no history of foot fracture or surgery. Those with a medical diagnosis of systematic diseases like diabetes mellitus, gout, rheumatoid arthritis, psychological problems, or had a pain intensity score of more than 20 mm at the lower back, hip, thigh, knee, and calf during weight-bearing activities were excluded. Additionally, participants who were unable to read and write the Thai language were excluded. The sample size was calculated based on a previous study, which reported that 92% of patient-reported outcome measure articles had a ratio of subject to items of 2, and that 90% of the articles had at least 100 participants or greater[32]. Therefore, a total of 100 individuals with chronic foot pain were recruited into the study.

### MOXFQ

MOXFQ is a region-specific questionnaire that contains 16 items that ask for information on the foot pain, walking/standing, and social interaction subscales; each item includes a 5-point Linkert scale ranging from 0 (no limitation) to 4 (maximum limitation)[16]. In order to

calculate the MOXFQ score, the raw score of each subscale is transformed into a metric of 0-100. The scores of all three subscales can be summed and converted to a metric of 0-100 to obtain the MOXFQ-index score. A greater score represents greater severity[16].

### VAS

The VAS item is used to ask individuals to rate their pain intensity, e.g., "Do you have foot pain? If yes, please specify the pain level". The respondents then rate their pain symptom severity by marking on the 10 cm line indicating (from left to right) no pain to the worst pain imaginable[33].

### FAAM

The FAAM is a 29-item questionnaire that comprises 21 items related to activities of daily living and 8 items related to sport activities. Each item can be scored with five choices that define the level of difficulty—from 4 (no difficulty) to 0 (unable to do) as well as a non-applicable choice (scores are not calculated in the total score of each subscale). The actual score is transformed into a percentage (out of 100) by dividing it by the highest potential score. A missing item is considered as non-applicable[15].

### SF-36

The SF-36 is a general questionnaire consisting of 36 items that is frequently used in clinical practice and research. This questionnaire aims to assess the general health and quality of life with eight subscales (physical functioning, role physical, role emotional, social functioning, mental health, energy/vitality, bodily pain, and general health perception). The raw score for each subscale is converted into a metric of 0-100, where a higher score represents a higher quality of life. Additionally, all subscales can be divided into physical and mental components. The score of any missing item is calculated from the average score of the other items in the same subscale[34].

### Procedures

This study recruited potential participants from physical therapy clinics and community-based settings located in Bangkok and its suburbs. Individuals with chronic foot pain were considered potential participants. Information about participant involvement and research details were distributed to the potential participants via research information sheets and consent forms, respectively. The potential participants had to agree and sign the consent form before the screening process. Then they were screened by the project manager using screening and demographic forms. The participants who passed the screening were assessed by a physical therapist with 3 years of clinical experience in the management of musculoskeletal conditions. The physical therapist used the diagnostic criteria recommended by the practice guidelines or scientific evidence for the assessment of each participant's foot problem, which consisted of plantar fasciitis[35], ankle instability[36], tendinopathy[37], hallux valgus[38], ankle impingement[39], tarsal tunnel syndrome[40], and metatarsalgia[41].

To examine the reliability of the Thai-MOXFQ, the values of the test-retest reliability and internal consistency were explored. For the test-retest reliability, 30 of the 100 participants, whose symptoms of foot problems remained stable over time from baseline to reassessment periods, were included. At baseline, these 30 participants were asked to complete the Thai-MOXFQ. Then they were asked to refrain from any foot pain intervention before reassessment. The interval time between baseline and reassessment ranged from 2 to 14 days[42]. At the beginning of reassessment, each participant was asked to complete the screening form. The screening form at reassessment consisted of the following two exclusion criteria: (1) the intensity of foot and/or ankle pain changed over time (VAS changes over 8 mm[43]), and (2) receiving any physical or medical interventions between sessions. The participants who satisfied these two criteria were asked to complete the Thai-MOXFQ.

The validation of the Thai-MOXFQ was conducted together with the internal consistency study among all of the 100 participants. The consent letter, screening form, demographic form, and the Thai-MOXFQ were used in the same way as in the test-retest reliability study. The participants were required to complete the Thai-MOXFQ, Thai-FAAM and Thai SF-36 individually. The scores obtained from the three subscales of the Thai-MOXFQ, i.e., pain, walking/standing, and social interaction, were analyzed in correlation with the VAS, FAAM, and SF-36 scores.

### Statistical analysis

The raw data from the questionnaire were entered into a Microsoft Excel 365 spreadsheet, whereas the statistical calculations were performed using SPSS version 22. A p-value of <0.05 was considered statistically significant.

The scores of the Thai-MOXFQ subscales were assessed for their test-retest reliability using the intraclass correlation coefficient (ICC). This study identified the ICC model as ICC (3,1) and absolute agreement. The data analysis involved the scores of the Thai-MOXFQ at the baseline assessment and the reassessment sessions. The ICC range from 0 to 1 was regarded as indicating no reproducibility to perfect reproducibility. ICC values between 0.5 and 0.75, between 0.75 and 0.9, and greater than 0.90 represented moderate, good, and excellent reliability, respectively[44]. The internal consistency of the Thai-MOXFQ subscales was assessed by means of Cronbach's alpha coefficient. The range of Cronbach's alpha coefficient was between 0 and 1, and the acceptable level of Cronbach's alpha coefficient was between 0.7 and 0.9. A Cronbach's alpha coefficient value over 0.9 was considered to indicate redundancy[45].

The Thai-MOXFQ data from the baseline assessment of the 100 participants were correlated with those of the Thai-FAAM, Thai SF-36, and VAS via Spearman's rank correlation coefficients. The positive and negative values were defined in the correlative direction in the same way and the opposite way, respectively. Negative values were presented in the relationships when comparing Thai-MOXFQ with Thai SF-36 and Thai-FAAM. Meanwhile, positive values were presented in the relationship between Thai-MOXFQ and VAS. The range of values from 0 to 1 was indicative of the magnitude of the relationship. A correlation coefficient of 0.40–0.59 was indicative of a moderate correlation and one of 0.6–0.79 represented a strong correlation[16].

## Results

The cross-cultural adaptation of MOXFQ was performed following the ISPOR guidelines. The Thai-MOXFQ was successfully translated with minor changes to account for cultural differences. In item 8, the wording "bus and car" was changed to "vehicle" in the Thai version. In item 9, "self-conscious" was replaced with "anxiety" in Thai according to the translator's suggestion. In item 12, the term "shooting pain" in the original version was changed to "sharp pain" in the Thai version. No MOXFQ items were removed during the translation. The questionnaire completion time was found to be not over seven minutes.

A group of 30 participants with chronic foot pain was included in the test-retest reliability study. The mean age of that group was 40.17±13.72 years, and the mean value of body mass index (BMI) was 26.05±5.12 kg/m$^2$. The diagnoses of the 30 participants consisted of plantar fasciitis, tendinopathy, hallux valgus, and ankle instability. These results are reported in Table 1.

**Table 1** Characteristics of 30 participants in the test-retest reliability study and 100 participants in the internal consistency and validity study

| Variables | Test-retest reliability study (n=30) | | Internal consistency and validity study (n=100) | |
|---|---|---|---|---|
| | n | Mean±S.D. | n | Mean±S.D. |
| Sex | | | | |
| Female | 18 | - | 56 | - |
| Male | 12 | - | 44 | - |
| Age (year) | - | 40.17±13.72 | - | 40.26±12.13 |
| Weight (kg) | - | 71.23±20.57 | - | 67.94±15.44 |
| Height (cm) | - | 164.80±10.37 | - | 164.80±9.08 |
| BMI (kg/m$^2$) | - | 26.05±5.12 | - | 24.85±4.17 |
| Diagnosis | | | | |
| Plantar fasciitis | 18 | - | 63 | - |
| Tendinopathy | 8 | - | 18 | - |
| Ankle instability | 2 | - | 9 | - |
| Tarsal tunnel syndrome | - | - | 4 | - |
| Ankle impingement | - | - | 3 | - |
| Hallux valgus | 2 | - | 2 | - |
| Metatarsalgia | - | - | 1 | - |

BMI=body mass index

**Table 2** Test-retest reliability of the Thai-MOXFQ (n=30)

| Item | ICC | 95% CI | | p-value |
|---|---|---|---|---|
| | | Lower limit | Upper limit | |
| Item 1 | 0.551 | 0.040 | 0.788 | 0.020 |
| Item 2 | 0.779 | 0.533 | 0.895 | <0.001 |
| Item 3 | 0.797 | 0.575 | 0.903 | <0.001 |
| Item 4 | 0.847 | 0.679 | 0.927 | <0.001 |
| Item 5 | 0.757 | 0.485 | 0.885 | <0.001 |
| Item 6 | 0.725 | 0.424 | 0.869 | <0.001 |
| Item 7 | 0.689 | 0.354 | 0.851 | 0.001 |
| Item 8 | 0.716 | 0.400 | 0.865 | <0.001 |
| Item 9 | 0.764 | 0.502 | 0.888 | <0.001 |
| Item 10 | 0.808 | 0.571 | 0.911 | <0.001 |
| Item 11 | 0.807 | 0.594 | 0.908 | <0.001 |
| Item 12 | 0.809 | 0.602 | 0.909 | <0.001 |
| Item 13 | 0.817 | 0.575 | 0.917 | <0.001 |
| Item 14 | 0.679 | 0.333 | 0.846 | 0.001 |
| Item 15 | 0.809 | 0.601 | 0.909 | <0.001 |
| Item 16 | 0.819 | 0.624 | 0.914 | <0.001 |

ICC was analyzed using the two-way random model with absolute agreement
ICC=intraclass correlation coefficient, CI=confidence interval

The test-retest reliability was evaluated via ICC (3,1). The interval time between the first and second assessments varied between 3 and 7 days. The ICC value of the Thai-MOXFQ subscales were 0.763 for the walking/standing subscale, 0.763 for the pain subscale, and 0.885 for the social interaction subscale. The ICC of the total score was 0.823. All Thai-MOXFQ subscale scores and the total score demonstrated a good level of test-retest reliability (ICC>0.75). Table 2 demonstrates the ICC values of the item-by-item analysis for each question. It was found that 3 questions—item 1 (ICC=0.551), item 7 (ICC=0.689), and item 14 (ICC=0.679)— had a moderate level of test-retest reliability.

Data from all 100 participants were used for analyzing the internal consistency and validity of the Thai-MOXFQ. The mean age of the participants was 40.26 ±12.13 years, and the mean value of BMI was 24.85±4.17 kg/$m^2$. According to the findings of the physical examination procedure, the following 7 musculoskeletal conditions were observed among our study participants: plantar fasciitis, tendinopathy, ankle instability, tarsal tunnel syndrome, ankle impingement, hallux valgus, and metatarsalgia; these data are shown in Table 1.

When calculating Cronbach's alpha coefficients of all 16 items, the Thai-MOXFQ showed an acceptable level of internal consistency (α=0.897). The values of the internal consistency of each subscale are reported in Table 3. The Cronbach's alpha coefficients of the walking/standing, pain, and social interaction subscales were 0.871, 0.738, and 0.748, respectively; this was indicative of an acceptable level of internal consistency without any item redundancy in each subscale. When one item was removed from the related subscale and the subscale's internal consistency was reanalyzed, it was found that the internal consistency of that subscale would decrease. This confirmed the contribution of the omitted item to the subscale. However, this was not the case for item 3 in the walking/standing subscale and item 10 in the social interaction subscale; when these two items were removed from their related subscales, the internal consistency values of the respective subscale increased slightly.

Spearman's correlation coefficient (r) was calculated in order to examine the construct validity of the Thai-MOXFQ. The analysis revealed that the Thai-MOXFQ exhibited strong negative correlations with the Thai-FAAM ADL domain (r=-0.711) and Thai SF-36 physical component (r=-0.681). Moreover, it had moderate negative correlations with the Thai-FAAM sport domain and the Thai SF-36 mental components, with correlation coefficients of -0.543 and -0.594, respectively (Table 4). Besides, the study found a slightly strong positive relationship (r=0.598) between the Thai-MOXFQ and the VAS (Table 4). The Spearman's rank correlation coefficients between each Thai-MOXFQ subscale and the Thai-FAAM, VAS, and Thai SF-36 (physical and mental components) were also calculated, as shown in Table 5. When comparing the correlation coefficients within each subscale, the walking/standing subscale showed the highest relationship with the ADL domain of FAAM, the pain subscale exhibited the highest correlation with the bodily pain of the Thai SF-36 physical component, and the social interaction subscale had the highest correlation with the ADL domain of FAAM.

**Table 3** Internal consistency of the Thai-MOXFQ

| Thai-MOXFQ | Cronbach's alpha coefficients; α |
|---|---|
| Walking/Standing subscale (7 items) | 0.871 |
| Removing item 2 | 0.838 |
| Removing item 3 | 0.885 |
| Removing item 4 | 0.843 |
| Removing item 5 | 0.853 |
| Removing item 6 | 0.858 |
| Removing item 7 | 0.837 |
| Removing item 8 | 0.850 |
| Pain subscale (5 items) | 0.738 |
| Removing item 1 | 0.715 |
| Removing item 11 | 0.672 |
| Removing item 12 | 0.684 |
| Removing item 15 | 0.701 |
| Removing item 16 | 0.686 |
| Social interaction subscale (4 items) | 0.748 |
| Removing item 9 | 0.683 |
| Removing item 10 | 0.776 |
| Removing item 13 | 0.628 |
| Removing item 14 | 0.656 |

MOXFQ=Manchester Oxford Foot Questionnaire

**Table 4** Construct validity of Thai-MOXFQ compared with Thai-FAAM, VAS, and Thai SF-36

| | Thai-FAAM | | VAS | Thai SF-36 | |
|---|---|---|---|---|---|
| | ADL | Sport | | PCS | MCS |
| Thai-MOXFQ | -0.711* | -0.543* | 0.598* | -0.681* | -0.594* |

Spearman's rank correlation, *The correlation is significant at the 0.05 level (2-tailed)
MOXFQ=Manchester Oxford foot Questionnaire, FAAM=foot and ankle ability measure, ADL=activities of daily living, VAS=visual analogue scale, PCS=physical component summary, MCS=mental component summary

**Table 5** Construct validity of each subscale of Thai-MOXFQ compared with Thai-FAAM, VAS, and Thai SF-36

| Thai-MOXFQ subscales | Thai-FAAM | | VAS | Thai SF-36 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | PCS | | | | MCS | | | | |
| | ADL | Sport | | PF | RP | BP | GH | RE | SF | MH | VT | |
| Walking/Standing | -0.614* | -0.535* | 0.484* | -0.573* | -0.505* | -0.543* | -0.467* | -0.418* | -0.526* | -0.425* | -0.378* | |
| Pain | -0.592* | -0.358* | 0.582* | -0.490* | -0.483* | -0.636* | -0.456* | -0.432* | -0.533* | -0.360* | -0.366* | |
| Social interaction | -0.607* | -0.511* | 0.518* | -0.438* | -0.461* | -0.568* | -0.415* | -0.466* | -0.575* | -0.418* | -0.393* | |

Spearman's rank correlation, *The correlation is significant at the 0.05 level (2-tailed)
MOXFQ=Manchester Oxford foot Questionnaire, FAAM=foot and ankle ability measure, SF-36=the medical outcome study short-form survey, PF=physical functioning, RP=role physical, BP=bodily pain, GH=general health perception, RE=role emotional, SF=social functioning, MH=mental health, VT=vitality, PCS=physical component summary, MCS=mental component summary

## Discussion

The MOXFQ was developed in its original English version as a tool to assess the pain and disability of patients undergoing hallux valgus surgery. Each item was developed by interviewing participants with a wide range of foot conditions. In the first phase, the MOXFQ was reported to be reliable, valid, and responsive in patients undergoing foot and ankle surgery[16]. Moreover, the MOXFQ has been suggested as appropriate for use in patients with foot and ankle conditions with supporting overall psychometric properties[19]. The advantages of MOXFQ are that it is short and simple to complete. The MOXFQ also contains social interaction subscales that specify cosmesis and self-consciousness related to the foot and shoes.

This study translated the MOXFQ from the original into a Thai version while employing cross-cultural adaptation. The cross-cultural adaptation processes were carried out according to the ISPOR guidelines[31]. The results showed that the Thai-MOXFQ was successfully translated with minor changes. Furthermore, it was tested in participants with chronic foot pain to prove that it can be effectively utilized in Thai populations.

Our study found that the Thai-MOXFQ had a good level of test-retest reliability. The ICCs of the Thai-MOXFQ subscales were 0.763 for walking and standing, 0.763 for pain, 0.885 for social interaction, and 0.823 for the total score. These were similar results to the ones obtained from the studies conducted on the Italian[21], Persian[22], and Korean[27] versions of MOXFQ. The original version was associated with higher ICC ranges, from 0.92 to 0.96, which was a similar finding to the ones reported by the studies on the Spanish[23], Dutch[25], German[26], and Chinese[30] versions of MOXFQ. In this study, the test-retest reliability was examined in individuals with chronic foot pain, while in that involving the original version, it was examined in patients undergoing hallux surgery. The difference in participants'

foot conditions might have resulted in the lower ICC values of the Thai-MOXFQ found in this study. The average interval times between baseline and reassessment in our investigation were 5±2 days, while a two-day interval was used in the study for the original version[16]. Conversely, interval times of approximate 19±4 days were reported in the Chinese version study[30]. In addition, the screening criteria for reassessment were not reported in the studies involving the other language versions of MOXFQ. This study used the VAS to detect changes between the baseline assessment and reassessments. The participants whose VAS scores changed by more than 8 mm were excluded. This could have introduced a bias in our test-retest reliability results.

The internal consistency was confirmed in all subscales of Thai-MOXFQ; the Cronbach's alpha coefficient was reported at a value of 0.871 for the walking/standing, 0.738 for the pain, and 0.748 for the social interaction subscales. The total score showed good internal consistency as evidenced by the coefficient value of 0.897. There was no item redundancy detected in the Thai-MOXFQ. Its pain and social interaction subscales showed similar results to those of the original version. Walking/standing subscale of the original MOXFQ was reported to have a Cronbach's alpha of over 0.9, which is similar to those related to the Korean[27] and Spanish versions[23]. Our results were in line with the findings reported in the studies of the Italian[21], Persian[22], Spanish[23], and Dutch[25] versions ($0.7<r<0.9$). The Chinese version has been reported to have the highest internal consistency, with r values ranging from 0.98 to 0.99 for all subscales[30]. Moreover, there have been no reports of removed items in any of the translated versions of MOXFQ.

Regarding validity, this study recruited participants with chronic foot pain, whereas participants undergoing hallux valgus surgery were recruited in the study of the original version of the tool. This study also identified the participants with overweight conditions (BMI=24.85±4.17 kg/m$^2$). Our study showed that 61% of its participants had plantar fasciitis. Therefore, the differences in medical conditions and BMI might alter the construct validity results of our study when compared with those of the original version[16].

The Thai-MOXFQ's pain subscale and VAS showed a moderate relationship; the level of the relationship was lower than that related to the Korean version study ($r=0.86$)[27]. The Korean version study recruited participants with hallux valgus specifically. Also, the Thai-MOXFQ allowed responses that included the frequency of symptoms, which is different from the level of pain intensity enquired for in the VAS. This might have resulted in a moderate positive relationship between the pain subscale of the Thai-MOXFQ and the VAS. An earlier study correlated the MOXFQ with another pain measurement using a numerical rating scale (NRS) and reported a moderate level of relationship between the two ($r=0.578$)[47]. In this study, as hypothesized, the Thai-MOXFQ's pain subscale and the bodily pain subscale of SF-36 showed similar results to those related to the original version. The study of the original version reported a negative strong relationship ($r=-0.64$)[17]. In SF-36, inquiries address the intensity and activity limitation aspects, whereas the Thai-MOXFQ pain subscale addresses the frequency of pain.

Regarding the walking/standing subscale, the Thai-MOXFQ showed a strong relationship with the activities of daily living (ADL) and a moderate relationship with the sport subscales of FAAM. FAAM could be responded to by identifying difficulties, while MOXFQ could be answered by identifying the frequency of pain that affects each activity. When compared with the SF-36, the bodily pain, physical functioning, role physical, and social functioning subscales exhibited moderate level correlations with the walking/standing subscale of the Thai-MOXFQ. These results support the construct validity of the Thai-MOXFQ

and were in line with the findings of the study conducted on the original version that compared MOXFQ with SF-36. The MOXFQ showed a moderate to strong relationship with the corresponding subscales of the other foot-specific questionnaires. For example, the MOXFQ showed a moderate to strong correlation with the American Orthopedic Foot and Ankle Society Scale (AOFAS) in the original and Spanish versions[16,17,23]. The German version study compared MOXFQ with the FAOS and found a moderate relationship with the ADL subscale of the FAOS[26]. MOXFQ was correlated with FAOS and a Self-Reported Foot and Ankle Outcome Score (SEFAS); a moderate level relationship between the FAOS-ADL and the functional limitation of SEFAS was reported[47]. The MOXFQ subscale of walking/standing has also been correlated with other foot-specific questionnaires; this correlation has reached an acceptable level of validity.

Concerning the social interaction subscale, this study found strong relationships between the MOXFQ's social interaction subscale and the ADL dimension of FAAM, as well as moderate relationships between the MOXFQ's social interaction subscale and the SF-36's bodily pain and social functioning subscales. These results were similar to the ones reported by the study of the Italian version[21]. Conversely, the original MOXFQ showed a weak relationship between the social interaction subscale and all SF-36 domains in participants undergoing hallux surgery (r of -0.038 to -0.367)[16]. An explanation for the different findings between the current study and that of the original version may be the fact that our study recruited participants with chronic foot pain that did not involve surgery. Therefore, our participants may have had concerns regarding their participation in work and recreational activities rather than those related to foot and shoes cosmesis when compared to patients undergoing surgery. The ADL items of FAAM ask about difficulties with standing, walking on even/uneven surfaces, step climbing, and simple activities. This could be related to item 13 in the Thai-MOXFQ, which states that "Foot pain prevents me from working or handling everyday tasks". Moreover, the FAAM's sport subscale includes running, jumping, landing, cutting movement, and recreational activities; these movements could be associated with item 14 of the Thai-MOXFQ that asks about limitations due to foot pain with respect to social events or recreational activities. These explain the relationship between the Thai-MOXFQ's social interaction subscale and the FAAM subscales.

Some limitations of this study are explained as follows. They must be taken into account when analyzing the results of the Thai-MOXFQ study. Firstly, our participants were recruited from a physical therapy clinic and via social platforms. Although all our participants reported foot pain symptoms as their chief concerns, they could still walk, transfer, and perform ADLs independently. The characteristics of current study's participants were different from those of the original English version study that was conducted in a hospital setting and recruited patients undergoing surgery. It is reasonable to assume that patients in the post-surgery phase would report experiencing higher pain levels and more difficulties performing self-ambulation than patients who are not undergoing surgery. The Thai version of the MOXFQ was tested in individuals with different foot conditions that were in the chronic phase, making the Thai-MOXFQ more specific to chronic foot pain than hallux valgus patient groups. Secondly, this study defined the time interval between baseline and reassessment as 2-14 days; this time interval may be inappropriate because it is possible that the pain level could change during this interval for some of the participants. However, some participants might have utilized memory recall when completing the questionnaire if a 2-day interval was selected. Therefore, the generalizability of the current findings must be interpreted with caution. Thirdly, this study examined only the construct validity of

Thai–MOXFQ; further studies are needed to examine the other types of validity as well as the responsiveness of the questionnaire, which would contribute toward making this tool a valuable outcome measure for clinical use. Additionally, the authors recommend investigating the Thai–MOXFQ in other foot conditions.

## Conclusion

The original English version of the MOXFQ was successfully translated into Thai with minor changes. The ensuing Thai–MOXFQ was found to be reliable and valid for use among Thai people with chronic foot pain. Our results support the usefulness of the Thai–MOXFQ for use in individuals suffering from musculoskeletal foot pain. This questionnaire is simple and can be easily completed (within seven minutes); therefore, it is feasible for application in clinical trials and various research settings. Furthermore, its ability to assess social interaction is a major advantage of the Thai–MOXFQ.

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## Conflict of interest

There are no potential conflicts of interest to declare.

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