

# Translation, cross-cultural adaptation and psychometric evaluation of the Greek version of the Western Ontario Meniscal Evaluation Tool (WOMET)

Chrysanthi Tsagkaraki, Michael A. Talias, Dimitrios Stasinopoulos & Demetris Lamnisis

To cite this article: Chrysanthi Tsagkaraki, Michael A. Talias, Dimitrios Stasinopoulos & Demetris Lamnisis (2022) Translation, cross-cultural adaptation and psychometric evaluation of the Greek version of the Western Ontario Meniscal Evaluation Tool (WOMET), *European Journal of Physiotherapy*, 24:5, 304-310, DOI: [10.1080/21679169.2021.1871778](https://doi.org/10.1080/21679169.2021.1871778)

To link to this article: <https://doi.org/10.1080/21679169.2021.1871778>



Published online: 16 Jan 2021.



Submit your article to this journal [↗](#)



Article views: 26





View related articles [↗](#)



View Crossmark data [↗](#)

## Translation, cross-cultural adaptation and psychometric evaluation of the Greek version of the Western Ontario Meniscal Evaluation Tool (WOMET)

Chrysanthi Tsagkaraki<sup>a</sup>, Michael A. Talias<sup>b</sup> , Dimitrios Stasinopoulos<sup>c</sup>  and Demetris Lamnisis<sup>d</sup> 

<sup>a</sup>Department of Health Sciences, School of Science, European University of Cyprus, Nicosia, Cyprus; <sup>b</sup>Healthcare Management Postgraduate Program, Open University of Cyprus, Nicosia, Cyprus; <sup>c</sup>Laboratory of Neuromuscular & Cardiovascular Study of Motion, Department of Physiotherapy, Faculty of Health and Caring Sciences, University of West Attica, Athens, Greece; <sup>d</sup>Cyprus Musculoskeletal and Sports Trauma Research Centre (CYMUSTREC), Department of Health Sciences, School of Science, European University of Cyprus, Nicosia, Cyprus

### ABSTRACT

**Background:** The Western Ontario Meniscal Evaluation Tool (WOMET) is a questionnaire designed to evaluate the health-related quality of life (HRQoL) of patients with meniscal pathology. The purpose of this study is to culturally adapt and validate the WOMET into Greek using the COSMIN checklist.

**Materials and Methods:** One-hundred three patients (40 females, 63 males; mean age:  $42.9 \pm 18.5$ ) with meniscal pathology were recruited in this study. The test-retest reliability of the WOMET was assessed with the intraclass correlation coefficient (ICC) while the internal consistency was evaluated using Cronbach's  $\alpha$ . The concurrent validity was assessed by evaluating the correlation among the WOMET and the Knee injury and Osteoarthritis Outcome Score (KOOS) while construct validity was assessed with Exploratory Factor Analysis (EFA).

**Results:** The ICC for the overall WOMET score was 0.91 while the Cronbach's  $\alpha$  was 0.96. WOMET was moderately to strongly correlated with the domains of the KOOS with the strongest correlation being between WOMET and Quality of Life domain ( $r=0.81$ ). EFA provided support for a two factor solution explaining the 66.2% of the total variability.

**Conclusions:** The Greek version of WOMET is considered a valid tool for measuring the HRQoL of Greek speaking patients with meniscal pathology.

**Abbreviations:** WOMET: Western Ontario Meniscal Evaluation Tool; HRQoL: Health-related quality of life; KOOS: Knee injury and Osteoarthritis Outcome Score; ICC: Intra-class correlation coefficient; COSMIN: Consensus-Based Standards for the Selection of Health Status Measurement Instrument; SEM: Standard error of measurement; MDC: Minimal detectable change; EFA: Exploratory Factor Analysis

### ARTICLE HISTORY

Received 27 August 2020  
Revised 27 October 2020  
Accepted 28 December 2020  
Published online 12 January 2021

### KEYWORDS

WOMET; reliability; validation; quality of life; meniscus pathology

### Background

The meniscus injury is causing functional impairment, pain and articular cartilage deterioration of the knee [1]. It is the second most common injury to the knee with an incidence rate of 12–14% and a prevalence of 61 per 100,000 individuals [2,3]. Meniscal injuries can be traumatic and/or degenerative [4,5]. Younger sports-active individuals suffer from traumatic lesions; with or without associated cruciateliga-ment tear [6]. Degenerative meniscal lesions occur more frequently in older patients and these are usually associated with various grades of cartilage degeneration, as a typical expression of an 'early osteoarthritic' articular environment [7]. Surgery and conservative treatment are the most frequent treatments of meniscal tears and surgeries that successfully replace or repair the meniscus are considered to delay or prevent the progress of osteoarthritis [8,9].

The meniscus injury has significant influence on patient's health related quality of life and therefore it is a serious health and economic problem of patients and health systems [10]. To facilitate physicians to consider the perception of

patients before administrating an appropriate rehabilitation and to enable them to assess the benefits of any interven-tion for patients, it is really important the existence of menis-cal pathology-specific patient reported outcome measures of the quality of life [11]. The Western Ontario Meniscal Evaluation Tool (WOMET) is the first self-reported meniscal pathology-specific Health Related Quality of Life (HRQoL) instrument to assess the symptoms that are related to patients with meniscal tear [12]. The WOMET includes 16 items grouped into three domains: the physical symptoms that includes nine items, the compound domain of sports, recreation, work, lifestyle that includes four items and the emotions with three items. The total score of WOMET ranges from 0 (best or least symptomatic score) to 1600 (worst or most symptomatic score). The score may be reported as a total overall score, a total score of each domain, or as a per-centage of normal by subtracting from 1600 the person's total score, dividing by 1600 and multiplying by 100 [12]. The WOMET has been translated into several languages apart from English and it has been found to have appropriate psy- chometric properties [12–17]. Therefore, it is considered to

be a valid tool for measuring the HRQoL of patients with meniscal pathology [12–14].

Because of the clinical importance of meniscal tears, it is very important for physicians, patients and health services in Greece and Cyprus to have a validated patient reported tool for HRQoL in Greek-speaking patients with meniscal pathology. Therefore a cross-cultural adaptation and validation of the WOMET questionnaire is necessary before administrating it to Greek-speaking patients. The purpose of this study was to translate and adapt the WOMET into the Greek language following the best practices and propose guidelines for HRQoL measures [18,19] and to investigate the psychometric properties of the Greek WOMET using the CONSMIN (CONsensus-based standards for the selection of health status Measurement Instruments) checklist for evaluating the methodological quality of studies on measurement properties [20,21]. The current study makes the hypothesis that the Greek version of the WOMET provides valid and reliable measurements of the HRQoL of Greek-speaking patients and has similar psychometric properties to the original English questionnaire.

## Methods

### Translation and cross-cultural adaptation

The WOMET was translated and culturally adapted into Greek following the steps and procedures described in Guillemin et al. [19]. Two independent translators who speak fluent English and Greek and whose mother language was Greek performed the translation of WOMET from English into Greek. One of the translators was professional physiotherapist and the second was orthopaedic surgeon. All discrepancies between the two translated versions were discussed between the two translators and a fluently English speaking Professor in Physiotherapy (DS) and resulted in a consensus version. Then one native English speaker with knowledge of Greek and one professional translator separately translated the Greek version of WOMET back into English. The two translators did not know the aim of the study and were blind to the original English version of the WOMET. Each back translator produced an independent version and the result of this step was the production of two different versions of WOMET. All translators, the professor in Physiotherapy (DS) and the original author (Alexandra Kirkley) reviewed the back translations, discussed and solved any discrepancies from the original version and produced the pilot version of the questionnaire. The pilot version of the Greek questionnaire was distributed in 20 patients with knee disorders (12 women and 8 men, mean age:  $43.1 \pm 10.2$  years) and they were asked to provide any comment on the questionnaire and state any words or questions that were difficult to comprehend. The result of this process was the production of the final Greek version of WOMET.

### Patients

A total of 103 patient with meniscal pathology (40 women and 63 men, mean age:  $42.9 \pm 18.5$ ) were recruited from

**Table 1.** Characteristic of patients.

| Variables                                     | N (%)                |
|---|----------------------|
| Female/Male                                   | 40 (38.8%)/63(61.2%) |
| Age (years; mean $\pm$ SD)                    | $42.9 \pm 18.5$      |
| BMI ( $\text{kg}/\text{m}^2$ ; mean $\pm$ SD) | $25.8 \pm 5.4$       |
| Education                                     |                      |
| Primary School                                | 22 (21.4%)           |
| High School                                   | 40 (38.8%)           |
| University degree                             | 41 (39.8%)           |
| Involved knee                                 |                      |
| Right knee                                    | 40 (38.8%)           |
| Left knee                                     | 45 (43.7%)           |
| Both knee                                     | 18 (17.5%)           |
| Symptom duration (months; mean $\pm$ )        | $14.8 \pm 6.4$       |

orthopaedic and physiotherapy clinics from two different countries, Greece (region of Crete) and Cyprus (city of Nicosia) between September 2017 and March 2018 (Table 1). Sufficient sample size was determined according to the rule of thumb of four to 10 patients per item, with a minimum number of 100 patients [22]. The inclusion criteria were the following: older than 18 years of old, be capable to read and speak Greek, diagnosis of meniscus injuries by an orthopaedic surgeon and confirmation of the diagnosis by magnetic resonance imaging (MRI). The exclusion criteria were the following: patients with previous leg surgery, report of any musculoskeletal disorder and refusal to participate in the study. The patients completed written informed consent before taking part in the study. The institutional ethics committee of the European University of Cyprus approved the protocol of the study and the study was carried out according to the Declaration of Helsinki.

### Reliability

The Greek version of WOMET questionnaire was completed two times by all participants. The first time was at their first visit to the orthopaedic or physiotherapy clinic and the second time was within 7-14 days after their first visit. This time period between the two completions was considered sufficient for not memorising the previous answers of the first completion and also for not causing any alteration in the clinical status of patients [23]. The patients did not receive any treatment between the first and second time to avoid the risk of occurring alterations in their health status and they also respond of having a stable symptom status between the first and second time of completing the questionnaire. Reliability was also evaluated by the internal consistency of all items.

### Validity

Concurrent validity was investigated by evaluating the association of the WOMET with the Greek version of the Knee injury and Osteoarthritis Outcome Score (KOOS) [24], a questionnaire that was completed from all patients together with the WOMET in their first visit. The KOOS was created to evaluate the opinion of the patient about the knee and its related problems [25,26]. It evaluates short and long-term symptoms and function in subjects with knee injury and

osteoarthritis and it has been found to have good psychometric properties. The Greek version of KOOS has previously found to have acceptable validity and reliability [24]. The KOOS consists of 5 different domains: Pain (nine items), Symptoms (seven items); Activity of Daily Living (ADL; 17 items), Sport and Recreation Function (Sports/Rec; five items) and Quality of Life (QoL; four items). A Likert scale is used for each item with five possible options ranging from 0 (No Problems) to 4 (Extreme Problems) and each of the five domains is calculated as the sum of its included items. In the current study, we make the following hypothesis:

1. The WOMET scale would demonstrate strong positive correlation with the Quality of Life subscale of KOOS since both scales are measures of the health-related quality of life.
2. The WOMET scale would demonstrate moderate positive correlation with four subscales of KOOS: Pain, Symptoms, Activity of Daily Living and Sport and Recreational Function.
3. The Physical Symptoms subscale of WOMET would demonstrate a moderate positive correlation with three subscales of KOOS: Symptoms, Pain and Activity of Daily Living.
4. The Sports/Recreational/Work/Lifestyle subscale of WOMET would demonstrate a moderate positive correlation with the recreational subscale of KOOS.
5. The Emotional subscale of WOMET would demonstrate a moderate positive correlation with the Quality of Life subscale of KOOS.

The construct validity of Greek WOMET was investigated through Exploratory Factor Analysis methods. This is a multivariate statistical method that is used to reveal the dimensionality of any questionnaire developed to measure complex concepts that are not directly measurable.

### **Ceiling and floor effects**

The total WOMET scale and the three subscales of the original version of WOMET were examined for ceiling and floor effects [27]. If the score of more than 33% of the patients are equal to the maximum value (ceiling effect) or minimum value (floor effect) then this is indicative of inadequate content validity [28].

### **Statistical analysis**

The normality test of Kolmogorov–Smirnov was used to investigate whether the distributions of the total WOMET scale and the three subscales of the original version of WOMET were normally distributed. If the data were normally distributed then parametric statistical tests were performed, otherwise, the non-parametric statistical tests were applied. The Intraclass Correlation Coefficient (ICC) with a two-way random model and type the absolute agreement were computed to evaluate the test–retest reliability of WOMET total scale, the three subscales of the original version of WOMET

and the subscales resulted from the Exploratory Factor Analysis [22,29], while the Cronbach's  $\alpha$  was computed to assess the internal consistency of each scale [30]. Acceptable values of Cronbach's  $\alpha$  are any value between 0.70 and 0.95 [31]. The minimum detectable change (MDC) which is the minimum difference between two measurements on the same patient that can be considered as a real change [32] was computed using the standard error of measurement (SEM) [33,34]. The SEM was calculated as the standard deviation (SD) of the scores times the square root of (1-ICC) while the MDC was calculated as the SEM times 1.96 times the square root of 2. Concurrent validity was assessed by computing the correlation coefficient of the WOMET total scale, the three subscales of the original version of WOMET and the subscales resulted from the Exploratory Factor Analysis with the KOOS five domains using either Pearson's correlation coefficient if data were normally distributed or Spearman's correlation coefficient if data were not normally distributed. A correlation coefficient between 0.50 and 0.75 indicates a moderate positive association while a correlation coefficient above 0.75 is evidence of a strong positive association.

Construct validity was investigated using the Exploratory Factor Analysis (EFA), after evaluating first whether it is appropriate by the Kaiser-Meyer-Olkin coefficient and Bartlett test of Sphericity. The Generalised Least Squares method was used as extraction method and the Promax method as a factor rotation. The Generalised Least Squares method is minimising the residuals between the observed and reproduced by the factors correlation and treats high communal variables as more important in the fitting process while Promax method allows factors to be rotated. A factor loading for an item  $\geq 0.60$  was the cut-off value for considering an item for inclusion to a factor.

The statistical analysis was done using the SPSS Statistical Package and the significance level of the statistical tests was set at  $p < 0.05$ .

## **Results**

### **Translation process and score distribution**

The words 'giving way', 'conscious' and 'frustration' had a different meaning in the Greek language or were difficult to find their appropriate translation. All involved translators and the original author (Alexandra Kirkley) discussed and solved those issues by rephrasing those words to produce an easy to understand and complete Greek version of WOMET. The pilot testing of the questionnaire did not indicate any difficulty in understanding and responding to any item. The scores of the total WOMET were within the interval from 112 to 1456, and no ceiling or floor effects were presented in both total WOMET and the three subscales of the original version of WOMET (Table 2).

### **Reliability**

The Cronbach's  $\alpha$  was 0.96 for the total WOMET scale while for the three subscales of the original version of WOMET the

**Table 2.** Score distribution and floor-ceiling effects of the Greek Western Ontario Meniscal Evaluation Tool (WOMET).

| Scale                            | Mean $\pm$ SD | Observed range | Theoretical range | Floor effect (%) <sup>a</sup> | Ceiling effect (%) <sup>a</sup> |
|----------------------------------|---------------|----------------|-------------------|-------------------------------|---------------------------------|
| Overall scale                    | 573 $\pm$ 285 | 112-1456       | 0-1600            | 0                             | 0                               |
| Physical symptoms                | 307 $\pm$ 226 | 0-900          | 0-900             | 4.85%                         | 1.94%                           |
| Sports/recreation/work/lifestyle | 153 $\pm$ 105 | 0-400          | 0-400             | 1.94%                         | 1.94%                           |
| Emotions                         | 113 $\pm$ 85  | 0-300          | 0-300             | 1.94%                         | 4.85%                           |

WOMET Western Ontario Meniscal Evaluation Tool.

<sup>a</sup>Percentage of patients with the worst (floor effect) and the best (ceiling effect) condition.

**Table 3.** Test-retest reliability and internal consistency of the Greek Western Ontario Meniscal Evaluation Tool (WOMET).

| Scale                            | Mean $\pm$ SD Test 1 | Mean $\pm$ SD Test 2 | ICC (95% CI)      | Cronbach's $\alpha$ |
|----------------------------------|----------------------|----------------------|-------------------|---------------------|
| Overall scale                    | 573 $\pm$ 285        | 612 $\pm$ 279        | 0.91 (0.85, 0.95) | 0.96                |
| Physical symptoms                | 307 $\pm$ 226        | 326 $\pm$ 231        | 0.85 (0.83, 0.92) | 0.94                |
| Sports/recreation/work/lifestyle | 153 $\pm$ 105        | 168 $\pm$ 111        | 0.83 (0.81, 0.90) | 0.82                |
| Emotions                         | 113 $\pm$ 85         | 118 $\pm$ 88         | 0.85 (0.82, 0.93) | 0.89                |

ICC: Intra-class correlation coefficient.

**Table 4.** Correlation coefficients between the Greek Western Ontario Meniscal Evaluation Tool and related subscales of Knee injury and Osteoarthritis Outcome Score (KOOS).

| KOOS                          | WOMET             |                                  |                   |                   |
|-------------------------------|-------------------|----------------------------------|-------------------|-------------------|
|                               | Physical symptoms | Sports/Recreation/Work/Lifestyle | Emotions          | Overall Score     |
| Symptoms                      | 0.64 <sup>†</sup> |                                  |                   | 0.53 <sup>†</sup> |
| Pain                          | 0.68 <sup>†</sup> |                                  |                   | 0.70 <sup>†</sup> |
| Activity of daily living      | 0.67 <sup>†</sup> |                                  |                   | 0.68 <sup>†</sup> |
| Sport and recreation Function |                   | 0.57 <sup>†</sup>                |                   | 0.63 <sup>†</sup> |
| Quality of life               |                   |                                  | 0.70 <sup>†</sup> | 0.81 <sup>†</sup> |

<sup>†</sup> $p$ -value < 0.01.

\* $p$ -value < 0.05.

Cronbach's  $\alpha$  was 0.94, 0.82 and 0.89 respectively. ICC were 0.91 (95% CI: 0.85, 0.95) for the WOMET total scale, 0.85 (95% CI: 0.83, 0.92) for physical symptoms subscale, 0.83 (95% CI: 0.81, 0.90) for sports/recreation/work/lifestyle subscale and 0.85 (95% CI: 0.82, 0.93) for emotions subscale. The SEM and MDC for total WOMET score were found to be 85.5 and 237.0 respectively (Table 3).

### Validity

The correlation coefficient analysis demonstrated that the total WOMET score was strongly positive correlated with the Quality of Life subscale of KOOS ( $r=0.81$ ) and moderate positive correlated with the other four subscales of KOOS, Pain ( $r=0.70$ ), Activity of Daily Living ( $r=0.68$ ), Sport and Recreation Function ( $r=0.63$ ) and Symptoms ( $r=0.53$ ) (Table 4). The Physical Symptoms subscale of the original version of WOMET had moderate positive correlation with the three domains of KOOS, Symptoms ( $r=0.64$ ), Pain ( $r=0.68$ ) and Activity of Daily Living ( $r=0.67$ ). A moderate positive correlation was also observed between Sports/Recreation/Work/Lifestyle subscale of the original version of WOMET and Sport and Recreation Function of KOOS ( $r=0.57$ ) and emotion subscale of the original version of WOMET and Quality of Life subscale of KOOS ( $r=0.70$ ). All correlation coefficients were statistically significant.

The Bartlett test of Sphericity was 566.5 ( $p < 0.001$ ) and the Kaiser-Meyer-Olkin coefficient for sampling adequacy was 0.83, indicating that factor analysis could be applied in the data collected by the WOMET. EFA resulted in two factors with eigenvalues greater than 1 explaining the 66.2% of the

total variance (Table 5). The first factor (physical domain) included eight items ('Stiffness after rising or sitting', 'Sharp pains after full weight-bearing', 'Weakness', 'Ability to perform specific skills', 'Crackling, grinding, or popping', 'Numbness', 'Pain or soreness after activities' and 'Swelling') which measure the influence of meniscal pathology on physical health. The second factor (emotional domain) included four items ('Fear or reinjury', 'Consciousness of the knee', 'Concern about the future of the knee' and 'Frustration or discouragement') which evaluate the impact of meniscal pathology on psychological health. Four items ('Effect on the ability to participate in activities', 'Loss of range of motion', 'Squatting ability' and 'Feeling of giving way or instability') were found to cross load in both factors and they were not included to any factor. The Cronbach's  $\alpha$  was 0.94 for the first factor (physical domain) and 0.90 for the second factor (emotional domain) while the ICC were 0.87 (95% CI: 0.85, 0.94) and 0.86 (95% CI: 0.83, 0.94) (Table 6). The physical domain had moderate positive correlation with the three domains of KOOS, Symptoms ( $r=0.67$ ), Pain ( $r=0.68$ ) and Activity of Daily Living ( $r=0.67$ ) while the emotional domain had moderate positive correlation with the Quality of Life subscale of KOOS ( $r=0.73$ ). All correlation coefficients were statistically significant.

### Discussion

The purpose of the present study was to translate, cross-culturally adapt and evaluate the psychometric properties of the WOMET into Greek. The results of this study showed acceptable psychometric properties (test-retest reliability,

**Table 5.** Results of the exploratory factor analysis of the Greek version of Western Ontario Meniscal Evaluation Tool (WOMET).

| Item   | Factor                     |                             | Communality |
|--|----------------------------|-----------------------------|-------------|
|  | Factor 1 (Physical domain) | Factor 2 (Emotional domain) |             |
| Stiffness after rising or sitting                  | <b>0.99</b>                | -0.02                       | 0.99        |
| Sharp pains after full weight-bearing              | <b>0.88</b>                | -0.15                       | 0.87        |
| Weakness   | <b>0.87</b>                | -0.11                       | 0.87        |
| Ability to perform specific skills                 | <b>0.87</b>                | -0.12                       | 0.91        |
| Crackling, grinding, or popping                    | <b>0.73</b>                | 0.15                        | 0.94        |
| Numbness   | <b>0.70</b>                | 0.10                        | 0.89        |
| Pain or soreness after activities                  | <b>0.64</b>                | 0.16                        | 0.88        |
| Swelling   | <b>0.64</b>                | 0.33                        | 0.91        |
| Effect on the ability to participate in activities | 0.51                       | 0.35                        | 0.97        |
| Loss of range of motion                            | 0.40                       | 0.29                        | 0.62        |
| Fear or reinjury                                   | -0.12                      | <b>0.97</b>                 | 0.98        |
| Consciousness of the knee                          | -0.15                      | <b>0.96</b>                 | 0.98        |
| Concern about the future of the knee               | -0.02                      | <b>0.82</b>                 | 0.89        |
| Frustration or discouragement                      | 0.08                       | <b>0.80</b>                 | 0.83        |
| Squatting ability                                  | 0.28                       | 0.49                        | 0.80        |
| Feeling of giving way or instability               | 0.44                       | 0.44                        | 0.94        |

Extraction method: Generalised Least Squares; rotation method: Promax. Factor loadings with an absolute value  $\geq 0.60$  are given in bold.

**Table 6.** Test-retest reliability and internal consistency of the 2-factor solution of Explanatory Factor Analysis and the correlation coefficient between the two factors and related subscales of Knee injury and Osteoarthritis Outcome Score (KOOS).

| Factor                      | ICC (95% CI)       | Cronbach's $\alpha$ | KOOS              |                   |                            |                                |                   |
|-----------------------------|--------------------|---------------------|-------------------|-------------------|----------------------------|--------------------------------|-------------------|
|                             |                    |                     | Symptoms          | Pain              | Activities of daily living | Sports/Recreational activities | Quality of life   |
| Factor 1 (Physical Domain)  | 0.88 (0.86 – 0.94) | 0.94                | 0.67 <sup>†</sup> | 0.68 <sup>†</sup> | 0.67 <sup>†</sup>          | 0.53 <sup>†</sup>              |                   |
| Factor 2 (Emotional Domain) | 0.86 (0.83 – 0.94) | 0.90                |                   |                   |                            |                                | 0.73 <sup>†</sup> |

ICC: intra-class correlation coefficient.

<sup>†</sup> $p$ -value < 0.01.

internal consistency, content, concurrent and construct validity) of the translated Greek version of the WOMET and endorse its use for the evaluation of HRQoL in Greek-speaking patients with meniscus pathology.

The test-retest reliability was evaluated by ICC and indicated that the total WOMET score and the three subscales of the original version of WOMET have good to excellent test-retest reliability. Therefore when no alterations are observed in the patient's clinical status then the repeated measurements of WOMET remain quite similar. The test-retest reliability of the Greek WOMET was similar and even better to the observed values of the original English version (ICC = 0.85), German (ICC = 0.90), Turkish (ICC = 0.88), and Chinese (ICC = 0.94) versions of WOMET [12,15–17]. The time interval of the two assessments varied between those validation studies with the shorter time period being 3 to 7 days applied in the Turkish version of WOMET [16] while the longer time period was two weeks and it was applied in the English version of WOMET. The German [15] and Chinese [17] versions of WOMET used a 7-day time interval between the two completions of the WOMET. The time period of 7 to 14 days used in our study was considered a sufficient time interval for not memorising previous responses and also avoiding the risk of changing the health status of the patients. The MDC score for the Greek total WOMET score was 237.0 (on a scale from 0 to 1600) indicating that a change of 237.0 points between the two times is the minimum difference required between measurements on the same patient to state that a real change is causing the difference and it is not due to a measurement error. The MDC score of 237.0 for the Greek WOMET is lower than the MDC of 281.0 for the Turkish

version of WOMET [16], although it is misleading to compare the MDC scores between studies as they are affected by several factors, such as the socio-demographic and clinical characteristics of the patients as well as the time interval between the initial and second completion of the questionnaire [23,35].

The Cronbach's  $\alpha$  value was used to assess the internal consistency of the Greek WOMET [36]. A satisfactory value of Cronbach's  $\alpha$  value is generally considered any value between 0.70 and 0.95. A value less than 0.70 may suggest that the items of the questionnaire may not be measuring the same concept. A Cronbach's  $\alpha$  value greater than 0.95 may be indicative of redundant items [36] and some of them could be eliminated from the questionnaire. The current study found a Cronbach's  $\alpha$  value of the total Greek WOMET score slightly higher than 0.95 and this might indicate that the questionnaire may include items that were reported in quite similar way by the patients. The Cronbach's  $\alpha$  of the total WOMET score reported by other studies was smaller and it was between 0.89 to 0.92. On the other hand, the Cronbach's  $\alpha$  of the three subscales of the original version of WOMET were acceptable and consistent with previous studies [13,15–17].

Since a gold standard questionnaire was not existed, concurrent validity of Greek WOMET was determined by evaluating its correlation with the five domains of the KOOS. Correlation coefficients between the total WOMET and the domains of the KOOS were moderate to strong with the highest correlation being with Quality of Life ( $r=0.81$ ) and Pain ( $r=0.70$ ). Concurrent validity of the German WOMET version was also investigated by the correlation coefficient

between the total WOMET and KOOS and they have reported a moderate correlation between the two scores ( $r=0.72$ ). Investigation of the construct validity of WOMET using Exploratory Factor Analysis provided support for a 2-factor solution (physical and emotional domains) explaining the 66.2% of the total variance. The 2-factor solution of the Greek WOMET have good to excellent test-retest reliability, ICC = 0.87 for the first factor and ICC = 0.86 for the second factor, and excellent internal consistency (Cronbach'  $\alpha$  equal to 0.94 for the first factor and 0.90 for the second factor). The first factor (physical domain) has moderate association with the KOOS subscales, Symptoms ( $r=0.67$ ), Pain ( $r=0.68$ ) and Activity of Daily Living ( $r=0.67$ ) while the second factor (emotional domain) has moderate association with the KOOS subscale Quality of Life ( $r=0.73$ ). Only the Persian version of WOMET [37] employed Exploratory Factor Analysis to study the structure of WOMET and found a 3-factor solution which is also slightly different to the structure assumed by the original version of WOMET [12]. None any other study employed factor analytic methods to assess the dimensions of the WOMET, therefore future studies in evaluating the psychometric properties of WOMET should apply those methods to reveal more clearly the dimensionality of WOMET.

The Greek WOMET has an acceptable content validity since no floor or ceiling effects have been observed. Similar floor or ceiling effects were observed in the other validation studies [13,15–17] enhancing the good content validity of WOMET.

The current study has some limitations. First, the patients participated in this study could not represent the whole Greek population, although the participants were from two different countries (Greece and Cyprus) with linguistic differences in their daily language. Those linguistic differences did not seem to influence the psychometric properties of WOMET, however it is reasonable to investigate the properties of WOMET in Greek patients from mainland Greece. Furthermore, we are not able to justify that the participated sample is a representative sample of the patients with meniscal pathology in Greece and Cyprus because there were not any previous national epidemiological studies. Another important drawback of our study was the absence of any evaluation of the responsiveness of the WOMET. The responsiveness of WOMET refers to its ability to capture changes in the patients' clinical status. Therefore, future studies are needed to evaluate the responsiveness of the Greek version of the WOMET.

## Conclusions

The results of this study demonstrated that the Greek version of the WOMET questionnaire has acceptable psychometric properties. Therefore, the Greek version of the WOMET is considered a valid tool for measuring the HRQoL of patients with meniscal pathology.

## Acknowledgements

The authors would like to thank all the physiotherapists in Crete (Greece) and Nicosia (Cyprus) for helping in the collection of the data by distributing the WOMET questionnaire to their patients.

## Ethics approval and consent to participate

The study protocol was approved by the review board of European University Cyprus. This study does not contain any interventions with human participants. The current study only involved persons who gave their written informed consent before entering to the study. There was no personal information that could associate any answers with any of the participants of the current study.

## Disclosure statement

The authors declare that there is no conflict of interest.

## Author contributions

DL and CT designed the project, collected the data and write the manuscript. DS contributed to the design of the project and critically revised the final manuscript. MT contributed to the statistics, the theory and design of the manuscript, and critically revised the final manuscript. All authors read and approved the final manuscript.

## ORCID

Michael A. Talias  <http://orcid.org/0000-0002-1802-5586>  
 Dimitrios Stasinopoulos  <http://orcid.org/0000-0001-8498-9343>  
 Demetris Lamnisis  <http://orcid.org/0000-0001-8535-6601>

## Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

## References

- [1] Laible C, Stein DA, Kiridly DN. Meniscal repair. *J Am Acad Orthop Surg.* 2013;21(4):204–213.
- [2] Majewski M, Susanne H, Klaus S. Epidemiology of athletic knee injuries: a 10-year study. *Knee.* 2006;13(3):184–188.
- [3] Stocker BD, Nyland JA, Caborn DN, Sternes R, et al. Results of the Kentucky high school football knee injury survey. *J Ky Med Assoc.* 1997;95(11):458–464.
- [4] Noble J. Clinical features of the degenerate meniscus with the results of meniscectomy. *Br J Surg.* 1975;62(12):977–981.
- [5] Poehling G, Ruch DS, Chabon SJ. The landscape of meniscal injuries. *Clin Sports Med.* 1990;9(3):539–549.
- [6] Englund M. Meniscal tear—a feature of osteoarthritis. *Acta Orthop Scand Suppl.* 2004;75(sup312):1–45.
- [7] Mesiha M, Zurakowski D, Soriano J, et al. Pathologic characteristics of the torn human meniscus. *Am J Sports Med.* 2007;35(1):103–112.
- [8] Frizziero A, Ferrari R, Giannotti E, et al. The meniscus tear: state of the art of rehabilitation protocols related to surgical procedures. *Muscles Ligaments Tendons J.* 2012;2(4):295–301.
- [9] Vaquero J, Forriol F. Meniscus tear surgery and meniscus replacement. *Muscles Ligaments Tendons J.* 2016;6(1):71–89.
- [10] Sgaglione NA, Steadman JR, Shaffer B, et al. Current concepts in meniscus surgery: resection to replacement. *Arthroscopy.* 2003;19(10):161–188.

- [11] Guyatt GH, Feeny DH, Patrick DL. Measuring health-related quality of life. *Ann Intern Med.* 1993;118(8):622–629.
- [12] Kirkley A, Griffin S, Whelan D. The development and validation of a quality of life-measurement tool for patients with meniscal pathology: the Western Ontario Meniscal Evaluation Tool (WOMET). *Clin J Sport Med.* 2007;17(5):349–356.
- [13] Sihvonen R, Järvelä T, Aho H, et al. Validation of the Western Ontario Meniscal Evaluation Tool (WOMET) for patients with a degenerative meniscal tear: a meniscal pathology-specific quality-of-life index. *J Bone Joint Surg Am.* 2012;94(10):165.
- [14] Tanner SM, Dainty KN, Marx RG, et al. Knee-specific quality-of-life instruments: which ones measure symptoms and disabilities most important to patients? *Am J Sports Med.* 2007;35(9):1450–1458.
- [15] Sgroi M, Däxle M, Kocak S, et al. Translation, validation, and cross-cultural adaptation of the Western Ontario Meniscal Evaluation Tool (WOMET) into German. *Knee Surg Sports Traumatol Arthrosc.* 2018;26(8):2332–2337.
- [16] Celik D, Demirel M, Kuş G, et al. Translation, cross-cultural adaptation, reliability and validity of the Turkish version of the Western Ontario Meniscal Evaluation Tool (WOMET). *Knee Surg Sports Traumatol Arthrosc.* 2015;23(3):816–825.
- [17] Tong WW, Wang W, Xu W. Development of a Chinese version of the Western Ontario Meniscal Evaluation Tool: cross-cultural adaptation and psychometric evaluation. *J Orthop Surg Res.* 2016;11(1):90.
- [18] Guillemin F. Cross-cultural adaptation and validation of health status measures. *Scand J Rheumatol.* 1995;24(2):61–63.
- [19] Guillemin F, Bombardier C, Beaton D. Cross-cultural adaptation of health-related quality of life measures: literature review and proposed guidelines. *J Clin Epidemiol.* 1993;46(12):1417–1432.
- [20] Mokkink LB, Terwee CB, Patrick DL, et al. The COSMIN checklist for assessing the methodological quality of studies on measurement properties of health status measurement instruments: an international Delphi study. *Qual Life Res.* 2010;19(4):539–549.
- [21] Mokkink LB, Terwee CB, Knol DL, et al. The COSMIN checklist for evaluating the methodological quality of studies on measurement properties: a clarification of its content. *BMC Med Res Methodol.* 2010;10:22.
- [22] Terwee CB, Bot SD, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol.* 2007;60(1):34–42.
- [23] Bennell KL, Bartam S, Crossley KM, et al. Outcome measures in patellofemoral pain syndrome: test retest reliability and interrelationships. *Phys Ther Sport.* 2000;1(2):32–41.
- [24] Moutzouri M, Tsoumpas P, Billis E, et al. Cross-cultural translation and validation of the Greek version of the Knee Injury and Osteoarthritis Outcome Score (KOOS) in patients with total knee replacement. *Disabil Rehabil.* 2015;37(16):1477–1483.
- [25] Roos EM, Roos HP, Lohmander LS, et al. Knee Injury and Osteoarthritis Outcome Score (KOOS)-development of a self-administered outcome measure. *J Orthop Sports Phys Ther.* 1998; 28(2):88–96.
- [26] Roos EM, Lohmander LS. The Knee injury and Osteoarthritis Outcome Score (KOOS): from joint injury to osteoarthritis. *Health Qual Life Outcomes.* 2003;1:64.
- [27] Howe TE, Dawson LJ, Syme G, et al. Evaluation of outcome measures for use in clinical practice for adults with musculoskeletal conditions of the knee: a systematic review. *Man Ther.* 2012; 17(2):100–118.
- [28] Paxton W, Fithian DC, Stone ML, et al. The reliability and validity of knee-specific and general health instruments in assessing acute patellar dislocation outcomes. *Am J Sports Med.* 2003;31(4): 487–492.
- [29] Bruton A, Conway J, Holgate S. Reliability: what is it, and how is it measured? *Physiotherapy.* 2000;86(2):94–99.
- [30] Rankin G, Stokes M. Reliability of assessment tools in rehabilitation: an illustration of appropriate statistical analyses. *Clin Rehabil.* 1998;12(3):187–199.
- [31] Thomas JR, Nelson JK. 1996. *Research methods in physical therapy.* 3rd ed. Champaign: Human Kinetics.
- [32] Crossley KM, Bennell KL, Cowan SM, et al. Analysis of outcome measures for persons with patellofemoral pain: which are reliable and valid? *Arch Phys Med Rehabil.* 2004;85(5):815–822.
- [33] Weir JP. Quantifying test-retest reliability using the intraclass correlation coefficient and the SEM. *J Strength Cond Res.* 2005;19(1): 231–240.
- [34] Atkinson G, Nevill AM. Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Med.* 1998;26(4):217–238.
- [35] Watson CJ, Propps M, Ratner J, et al. Reliability and responsiveness of the lower extremity functional scale and the anterior knee pain scale in patients with anterior knee pain. *J Orthop Sports Phys Ther.* 2005;35(3):136–146.
- [36] Tavakol M, Dennick R. Making sense of Cronbach's alpha. *Int J Med Educ.* 2011;2:53–55.
- [37] Ebrahimi N, Naghdi S, Ansari NN, et al. Statistical validity and reliability of the Persian version of the Western Ontario Meniscal Evaluation Tool (WOMET) according to COSMIN checklist. *BMC Musculoskelet Disord.* 2020;21(1):183.