

ORIGINAL PAPER ΕΡΕΥΝΗΤΙΚΗ ΕΡΓΑΣΙΑ

Validity and reliability of the shortened Greek version of the Western Ontario Rotator Cuff Index

OBJECTIVE To assess the reliability and validity of the shortened Greek version of the Western Ontario Rotator Cuff Index (Short-WORC) in patients with rotator cuff-related pain (RCRP). **METHOD** International published recommendations were followed for the translation and cross-cultural adaptation process. A total of 120 patients (mean age \pm SD=48.5 \pm 15.33 years, 56 women and 64 men) with RCRP completed the Greek versions of the Short-WORC, Disability of the Arm, Shoulder, and Hand (DASH) questionnaire and Rand-36 Item Health Survey. A total of 112 patients filled out the Greek versions of the Short-WORC twice and were included in the test-retest reliability analysis. **RESULTS** One linguistic discrepancy was identified and adapted in the Greek language. The Greek version of the Short-WORC showed an acceptable face and content validity. The questionnaire presented a high internal consistency (Cronbach's α =0.84). The test-retest reliability was excellent suggesting an intraclass correlation coefficient (ICC) of 0.94 (95% confidence interval: 0.90–0.96). The standard error of measurement and minimal detectable change were found to be 5.6% and 15.6%, respectively. No ceiling or floor effects were identified. There was a strong correlation between the Greek versions of the Short-WORC and DASH (r =0.71), and a weak to moderate correlation between the Greek version of the Short-WORC and the Rand-36 Item Health Survey (r =0.30–0.59). **CONCLUSIONS** The Greek version of the Short-WORC is an applicable, reliable, and valid self-reported outcome measure of health-related quality of life in patients with RCRP. Further research investigating the responsiveness of the questionnaire would be valuable for its future clinical use.

Rotator cuff related pain (RCRP) is estimated to account for more than 70% of all shoulder musculoskeletal complaints.^{1–3} Patients with RCRP present a complex clinical picture including shoulder pain, reduced mobility and increased functional impairment of daily activities causing significant associated healthcare costs.^{4,5} The most common pathoanatomical sources of pain in RCRP include tendinopathy, subacromial pain syndrome, bursitis and partial or full-thickness tears of the rotator cuff.^{6,7} The therapeutic approaches in patients with RCRP are primarily aimed at improving their functional status and quality of life.^{8,9} Consequently, using valid and reliable patient-rated outcome measures (PROMs) is considered critical to provide prognosis, assess the treatment outcome, and facilitate clinical decision-making when treating patients with RCRP.¹⁰

The Western Ontario Rotator Cuff Index (WORC) developed by Kirkley et al is one of the most sensitive and highly responsive PROMs in patients with RCRP.^{9,10} The WORC includes 21 items in five domains (i.e., pain and physical symptoms, sports and recreation, work, lifestyle and emotions).⁹ A visual analogue scale from 0 to 100 is used to answer each item resulting in a total questionnaire score between 0 and 2100.⁹ The WORC has been translated and tested for its psychometric properties in 13 languages including Greek.¹¹ Despite the wide clinical and research use of the WORC, some critical limitations have been addressed, such as the increased response burden and its questionable structural validity.^{11–13} To overcome these concerns, a shorter version of the WORC (Short-WORC) has been proposed that includes 7 of the 21 items from

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Η εγκυρότητα και η αξιοπιστία της σύντομης ελληνικής έκδοσης της κλίμακας Western Ontario Rotator Cuff

Περίληψη στο τέλος του άρθρου

Key words

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the full version.¹⁴ The main focus of the Short-WORC is on activity limitations; therefore, it contains only items from the “work” and “lifestyle” domains of the WORC.¹⁴ Interestingly, the Short-WORC has shown excellent reliability, validity, and responsiveness in different patient groups such as shoulder pain, tears of the rotator cuff after surgical repair, total shoulder arthroplasty and shoulder osteoarthritis.^{8,15–17} The Short-WORC has shown similar responsiveness, higher factorial validity and reduced response burden compared to the WORC.¹⁴ Consequently, it has been recommended as a clinically useful PROM in patients with RCRP.⁸

Using PROMs in different languages requires a rigorous cross-cultural adaptation process and subsequent careful testing of the psychometric properties of the new version.^{18,19} To our knowledge, a Greek version of the Short-WORC has not been researched yet. We hypothesized that a reliable and valid Greek version of the questionnaire would offer a clinically useful outcome measure for patients with RCRP. Therefore, we aimed to evaluate the psychometric properties of the reliability and validity of the Greek version of the Short-WORC in a cohort of Greek-speaking patients with RCRP.

MATERIAL AND METHOD

Cross-cultural adaptation

Before starting the study, permission was obtained from the developer authors. For the translation and cross-cultural adaptation, a merged process of international recommendations and published guidelines was followed.^{18,20}

Two independent bilingual translators completed two forward translation drafts. A reconciliation committee synthesized the two versions through a consensus process and produced the first forward translation version. Subsequently, two different translators whose first language was English and were fluent in Greek independently proceeded into back translation. An expert committee reviewed the back translation versions and examined them for conceptual equivalence. All discrepancies between back and forward translations were resolved using a consensus process. The committee focused on the semantic, idiomatic, experimental and conceptual equivalence between the forward and back translation.^{19,20} We followed a process of formal evaluation of the comparability of language and the similarity of interpretability by a committee of five physiotherapy researchers using a seven-point Likert scale was used (1: extremely comparable/similar, 7: not at all comparable/similar). Six individuals (3 men and 3 women with a mean age of 48.1 years) were recruited for the cognitive debriefing of the pre-final version of the questionnaire. Based on the evaluation of all comments, the pre-final version of the questionnaire was completed for pilot testing. Sixteen patients (8 men and 8 women, mean age: 35.4 years) with RCRP were interviewed regarding the comprehensibility (wording, terminology, instructions, and clar-

ity of the response options), and the relevance to their condition of the included items. The final version of the questionnaire was then produced.

Patients and procedures

Individuals with RCRP were recruited from private physiotherapy clinics in Greece between January 2021 and December 2022. Orthopedic surgeons confirmed the participants' eligibility. The medical diagnosis included partial or full-thickness tear of the rotator cuff, calcific tendonitis, and rotator cuff tendinopathy. To be included, patients should be older than 18 years old and able to read Greek. Patients were excluded if they could not communicate in Greek, were under 18 years old, had neck, thoracic or upper limb problems other than RCRP affecting their shoulder function, or presented systemic inflammatory diseases, fracture, tumor, neurological disorders or cognitive impairments. Before entering the study, all patients signed an informed consent form. During the initial evaluation, an independent assessor recorded participants' demographic characteristics, including age, sex, body mass index and dominant and painful side. Ethical approval was provided by the Ethics Committee of the University of West Attica (ID: 41370/18.4.2022).

The convergent validity of the questionnaire was assessed by comparing the results between the Greek versions of the Short-WORC, DASH questionnaire and Rand-36 Item Health Survey. The Short-WORC includes seven items, each of which is scored using a visual analogue scale from 0 to 100 (the worst possible functional limitation) (tab. 1).¹⁴ The total Short-WORC score ranges between 0 (the lowest score) and 700 (the highest score) or is expressed as a percentage (final score/700 × 100%). The DASH questionnaire is a 30-item self-report questionnaire, scored 0 (no disability) to 100 (highest disability).²¹ The Greek version of DASH has shown excellent test-retest reliability and high correlation with WORC.^{11,22} The Rand-36 Item Health Survey is a quality-of-life questionnaire containing eight domains (i.e., physical functioning, bodily pain, role limitations due to physical health problems, role limitations due to personal or emotional problems, emotional well-being, social functioning, energy/fatigue, and general health perceptions). The test-retest reliability of the Rand-36 Item Health Survey was found excellent with a poor to moderate correlation with WORC.^{11,23} Participants filled out all questionnaires in a quiet place without help.

The test-retest reliability of the Greek version of the Short-WORC was examined by asking the participants to fill in a second copy of the translated version between two and seven days after their first visit. Before the second administration of the questionnaire, patients were asked if their shoulder pain-related health status had changed since the first visit. In the case of a change, patients were excluded from the second measurement.

Statistical analysis

According to Consensus-based Standards for the Selection of Health Measurement Instruments (COSMIN) recommendations, a

Table 1. The seven items of the Greek version of the Short-WORC questionnaire.

1. Πόση δυσκολία βιώνετε στις καθημερινές δραστηριότητες που αφορούν στο σπίτι ή στην αυλή;	Καθόλου δυσκολία	Μέγιστη δυσκολία
2. Πόση δυσκολία βιώνετε όταν εργάζεστε σε θέσεις πάνω από το ύψος του ώμου;	Καθόλου δυσκολία	Μέγιστη δυσκολία
3. Πόσο χρησιμοποιείτε το μη εμπλεκόμενο χέρι σας για να αντισταθμίσετε το τραυματισμένο σας;	Καθόλου	Συνεχώς
4. Πόση δυσκολία βιώνετε στο να σηκώνετε βαριά αντικείμενα κρατώντας τα στο επίπεδο του ώμου ή κάτω από αυτό;	Καθόλου δυσκολία	Μέγιστη δυσκολία
5. Πόση δυσκολία έχετε να κοιμηθείτε εξ αιτίας του ώμου σας;	Καθόλου δυσκολία	Μέγιστη δυσκολία
6. Πόση δυσκολία βιώνετε με το να φτιάξετε τα μαλλιά σας εξ αιτίας του ώμου σας;	Καθόλου δυσκολία	Μέγιστη δυσκολία
7. Πόση δυσκολία έχετε να ντυθείτε ή να ξεντυθείτε;	Καθόλου δυσκολία	Μέγιστη δυσκολία

Short-WORC: Short-Western Ontario Rotator Cuff Index

minimum sample size of 100 participants is enough for a validation study.^{24,25} To allow for a 10% loss to follow-up, our sample size was increased to 120 participants. The Shapiro-Wilk test and Q-Q plots were used to confirm that the data were normally distributed. We used descriptive statistics to analyze demographic characteristics (i.e., age, sex ratio, body mass index, painful and dominant side) and outcome measures. Item-content relevance was assessed based on the ratings of 9 experts (research committee and clinicians) and 16 patients with RCRP. Aiken's coefficient (V) was used to analyze each item's content validity (values >0.70 were considered acceptable validity).²⁶

Cronbach's α was used for the evaluation of internal consistency of the Short-WORC. Values of 0.70–0.90 were considered of good internal consistency. Test-retest reliability was evaluated using the ICC (two-way random model, absolute agreement) with 95% confidence interval (CI). Reliability was classified as excellent for ICC values >0.75, fair for ICC values between 0.4 and 0.75, and poor for ICC values <0.4.²⁷ To assess absolute reliability, we calculated the standard error of measurement (SEM) [$SEM=SD \times \sqrt{(1-\text{test-retest reliability coefficient})}$] and minimal detectable change [$MDC_{95}=1.96 \times \sqrt{2} \times SEM$].

The content validity index (CVI) was calculated using the items rated >3 divided by the number of experts. CVI values >0.83 were considered acceptable.²⁶ Construct validity was evaluated by estimating the Pearson's correlation coefficient (r) between the

total score of the first administration of the Greek versions of the Short-WORC, DASH and Rand-36 Item Health Survey. Pearson's correlation values ≥ 0.70 , between 0.51 and 0.69 and ≤ 0.50 were classified as high, moderate, and low, respectively.²⁷ We hypothesized a strong correlation between the Greek versions of the Short-WORC and DASH and a poor to moderate correlation with the Rand-36 Item Health Survey. To assess feasibility, we recorded the time to complete the questionnaire under investigation. Floor and ceiling effects were considered if more than 15% of the participants scored the lowest (0) or the highest (700) score. The Statistical Package for Social Sciences (SPSS), version 25.0 software (SPSS Inc, Chicago, IL, USA) was used for data analysis ($p < 0.05$).

RESULTS

One minor linguistic discrepancy was identified during the cross-cultural adaptation process and was resolved through a consensus by the research committee. Specifically, a literal translation for the word "extreme" was considered inappropriate and the word "maximum" translated into Greek was used. Five experts and 16 patients with RCRP (9 women and 7 men; mean age \pm SD: 48.9 \pm 10.1 years) were interviewed for the content validity of the PROM. Participants reported no issues regarding comprehensiveness. All items were rated as appropriate and relevant to their condition while the wording and comprehensibility of the instructions and responses were rated as clear.

The sample consisted of 120 patients with RCRP (64 men and 56 women) with a mean age (\pm SD) of 48.5 (\pm 15.33) years. Participants' demographic characteristics are shown in table 2. The time needed to complete the questionnaire ranged between two and three minutes.

Eight subjects reported a significant change in their health condition between the first and second administration of the Short-WORC and were excluded from the reliability analysis. Hence, 112 patients were finally included in the reliability analysis, resulting in an excellent test-retest reliability (ICC=0.94, 95% CI=0.90 to 0.96). The Cronbach's α was equal to 0.84, suggesting an acceptable internal consistency of the questionnaire (tab. 3). The SEM and the MDC_{95} were found to be 39.4 (5.6%) and 109.2 (15.6%) points, respectively.

The Item-CVI ranged between 0.97 and 1.00, the scale-CVI/universal agreement was 0.95 and the scale-CVI/average was 0.97. A strong correlation was found between the Greek versions of the Short-WORC and DASH questionnaires ($r=0.713$; $p < 0.001$) (tab. 3). Weak to moderate negative correlations were found between the Short-WORC and the subdomains of the Rand-36 Item Health Survey (0.22–0.616, $p < 0.01$) (tab. 3). No ceiling or floor effects were detected.

Table 2. Demographic and clinical characteristics of participants (n=120).

Characteristic	Mean±SD (range) or no (percentage)
Age (years)	48.5±15.33 (18–84)
Sex	
Men	64 (53.3%)
Women	56 (46.7%)
Dominant side	
Right	90 (75%)
Left	30 (25%)
Affected side	
Right	82 (68.3%)
Left	38 (31.7%)
Height (cm)	170.5±8.5 (152–193)
Weight (kg)	76.5±14.3 (47–120)
Short-WORC	53.1% ±23
Points	372±161 (42–653)
DASH	43.7±20.9 (1.7–90.8)
Rand-36 Item Health Score	
Physical functioning	64.4±17.9
Physical health	47.4±32.7
Emotional problems	61.8±32.4
Energy/fatigue	54.3±20.1
Emotional well-being	60.2±20.2
Social functioning	68.5±19.5
Pain	53.2±21.6
General health	63.3±14.9
Health change	62.9±18.3

Short-WORC: Short-Western Ontario Rotator Cuff Index, DASH: Disability of the Arm, Shoulder, and Hand questionnaire, SD: Standard deviation, N: Sample

DISCUSSION

The results of the present study suggest that the Greek version of the Short-WORC is a comprehensible and easy-to-use outcome measure of health-related quality of life in patients with RCRP. The Short-WORC showed excellent repeatability with a small measurement error. Also, it presented acceptable face and content validity with a strong correlation compared to DASH. The psychometric properties of the Greek version of the Short-WORC were comparable to the original and Persian versions (tab. 3).

Concerning the translation and cross-cultural adaptation process we found a minor linguistic discrepancy between the original and the Greek translation of the word “extreme”. As in our study, minor changes were reported in the Persian translation which followed a similar merged methodology from published guidelines.^{19,23,24} The present study used a systematic assessment of the semantic, idiomatic, experiential, and conceptual equivalences between the original and the Greek version; hence, the face and content validity of the questionnaire were enhanced.¹¹ Further, pilot testing of the questionnaire in the clinical encounter confirmed its understandability and relevance which facilitated the production of the final version.^{28,29}

The Greek version of the Short-WORC showed a high Cronbach's alpha (0.84) that was comparable to the original version (0.87) (tab. 3). The literature suggests that a Cron-

Table 3. Measurement properties of translated Short-WORC versions.

	Greek (n=120)	English (n=177)	Persian (n=130)
Reproducibility ICC (95% CI)	0.94 (0.90–0.96)	0.89 (0.80–0.94)	0.95 (0.93–0.96)
Internal consistency (Cronbach's alpha)	0.84	0.87	0.97
Measurement error (out of 700 points)	SEM: 5.6% (39.4) MDC ₉₅ : 15.6% (109.2)	SEM: 8.8% MDC ₉₀ : 20.4%	SEM: 2.12% MDC ₉₀ : 10.4%
Responsiveness (out of 700 points)	–	SRM: 1.20	MCID: 28.56
Convergent validity	0.71 (DASH) 0.44 (RAND-36 PF) 0.44 (RAND-36 PH) 0.28 (RAND-36 EP) 0.29 (RAND-36 E/F) 0.28 (RAND-36 EWB) 0.41 (RAND-36 SF) 0.61 (RAND-36 P) 0.22 (RAND-36 GH) 0.29 (RAND-36 HC)	0.77 (DASH) 0.92–0.97 (WORC) 0.63 (SPADI) 0.41 (SF-12 PCS) 0.51 (SF-12 MCS) 0.69 (SST) 0.77 (ASES) 0.82 (RCMS)	0.79 (quick DASH) 0.92 (WORC) 0.82 (SPADI) 0.76 (SF-36 PF) 0.71 (SF-36 MH)
Ceiling and floor effects	0 and 0	0 and 3.8%	0 and 1%

Short-WORC: Short-Western Ontario Rotator Cuff Index, ICC: Intraclass correlation coefficient, DASH: Disability of the Arm, Shoulder and Hand, SEM: Standard error of measurement, MDC: Minimal detectable change, MCID: Minimal clinically important difference, PF: Physical functioning, PH: Physical health, EP: Emotional problems, E/F: Energy/fatigue, EWB: Emotional well-being, SF: Social functioning, P: Pain, GH: General health, SF-36: Short form-36, HC: Health change, MH: Mental health, SPADI: Shoulder Pain and Disability Index, SST: Simple Shoulder Test, SF12-PCS: Short form 12 Physical Component Survey, SF12-MCS: Short form 12 mental component survey, RCMS: Relative Constant-Murley Score, ASES: American Shoulder and Elbow Surgeons questionnaire, SRM: Standardized response mean

bach's $\alpha > 0.95$ may indicate that some items of a questionnaire are redundant and unnecessary;^{30,31} therefore, the use of a shorter version of the WORC was suggested to offer better internal consistency.³² In the same line, our findings showed that the Greek version of Short-WORC presented an acceptable but lower than the 0.95 Cronbach's α that was reported in the Greek WORC version.¹⁷

Test-retest reliability of the Greek version of the Short-WORC was excellent (ICC: 0.94) and similar to other published versions (ICC: 0.84–0.97) (tab. 3). The reported error of measurement was small (SEM: 5.6% and MDC₉₅: 15.6%), and comparable to the original version (tab. 3). Of note, the Persian version suggested less SEM and MDC compared to the original version. This was attributed to the different sample characteristics and the longer time intervals between test-rest measurements.¹⁵ When assessing the psychometric properties of a PROM, a key factor in reliability assessment is the time interval between test-retest administrations.²⁸ Despite using a time interval from two to seven days to ensure that the patient's condition had not changed, some patients reported significant improvements in health status and were excluded from the reliability analysis. However, the short time interval between the measurements may have increased the risk of recall bias.³³

The convergent validity of the Greek version of the Short-WORC was evaluated using the DASH questionnaire, which is a region-specific PROM. Our findings suggested a strong correlation between the instruments, which was comparable to previously published versions (0.77–0.95).^{10,11,24} Although the correlation between the Short-WORC and DASH was strong, it was not perfect. An explanation may lie in the comparison between a disease-specific and a region-specific outcome measure. Nevertheless, the convergent validity of the Short-WORC was similar to that one reported between the Greek versions of the WORC and DASH (0.80). Considering that the shortened version of the WORC is less time-consuming,

it can be recommended as a valid and convenient instrument to measure shoulder function in patients with RCRP. The correlations between the Short-WORC and Rand-36 Item Health Survey were found to be poor to moderate in all subscales. Our results were consistent with the English and Persian versions of the Short-WORC.^{14,15,17} A logical explanation for these results may be that the structure of the Rand-36 Item Health Survey contains too generic domains to measure the quality of life that can be irrelevant to shoulder dysfunction.

Several limitations may apply in the present study. We acknowledge that a period between two and seven days for test-retest reliability may have substantially increased the risk of recall bias.³⁴ Although a period of seven to fourteen days is considered ideal in musculoskeletal research,³⁴ we used a shorter time to limit possible changes in a patient's condition between the measurements. The inclusion criteria of our study suggest that the present results can be generalized only in patients with RCRP. Further research to investigate the psychometric properties of the current PROM in other patient groups with other shoulder musculoskeletal disorders could be valuable. Another limitation is that we did not evaluate the responsiveness of the questionnaire which is a critical psychometric property to detect clinically important changes over time.²⁰ Hence, a further evaluation of responsiveness is important for the clinical use of the Greek version of the Short-WORC.

In conclusion, the Greek version of the Short-WORC is a comprehensible and applicable outcome measure of health-related quality of life in Greek-speaking patients with RCRP. The PROM showed excellent internal consistency, repeatability, and a strong correlation with the DASH questionnaire. Based on the present findings, the questionnaire can be suggested as a standard outcome measure in the management of the condition. Further research on the responsiveness of the Greek version of the Short-WORC is required.

ΠΕΡΙΛΗΨΗ

Η εγκυρότητα και η αξιοπιστία της σύντομης ελληνικής έκδοσης της κλίμακας Western Ontario Rotator Cuff

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ΣΚΟΠΟΣ Η αξιολόγηση της αξιοπιστίας και της εγκυρότητας της ελληνικής σύντομης έκδοσης του δείκτη Western Ontario Rotator Cuff (Short-WORC) σε ασθενείς με πόνο που σχετίζεται με το στροφικό πέταλο του ώμου. **ΥΛΙΚΟ-ΜΕ-**

ΘΥΔΟΣ Ακολούθησαν οι διεθνείς δημοσιευμένες κατευθυντήριες οδηγίες για τη διαδικασία μετάφρασης και διαπολιτισμικής προσαρμογής. Ένα σύνολο 120 ασθενών με μέση ηλικία (\pm τυπική απόκλιση) τα 48,5 έτη (\pm 15,33) (56 γυναίκες και 64 άνδρες) με πόνο που σχετίζεται με το στροφικό πέταλο του ώμου συμπλήρωσαν τις ελληνικές εκδόσεις των ερωτηματολογίων Short-WORC, Disability of the Arm, Shoulder and Hand (DASH) και Rand-36 Item Health Survey. Από αυτούς 112 ασθενείς συμπλήρωσαν δύο φορές την ελληνική έκδοση της κλίμακας Short-WORC και συμπεριλήφθηκαν στην ανάλυση δοκιμής-επανεξέτασης. **ΑΠΟΤΕΛΕΣΜΑΤΑ** Εντοπίστηκε μια γλωσσική ασυμφωνία, η οποία προσαρμόστηκε άμεσα στην ελληνική γλώσσα. Η φαινομενική εγκυρότητα, καθώς και η εγκυρότητα περιεχομένου αξιολογήθηκαν ως αποδεκτές. Η ελληνική έκδοση της κλίμακας Short-WORC έδειξε υψηλή εσωτερική συνοχή (Cronbach's $\alpha=0,84$). Η αξιοπιστία δοκιμής-επανεξέτασης ήταν άριστη (συντελεστής ενδοταξικής συσχέτισης= $0,94$, διάστημα εμπιστοσύνης $95\%=0,90-0,96$). Το τυπικό σφάλμα μέτρησης και η ελάχιστη ανιχνεύσιμη αλλαγή βρέθηκαν $5,6\%$ και $13,6\%$, αντίστοιχα. Δεν εντοπίστηκαν φαινόμενα οροφής ή δαπέδου. Υπήρχε ισχυρή συσχέτιση μεταξύ των ελληνικών εκδόσεων των ερωτηματολογίων Short-WORC και DASH ($r=0,71$) και ασθενής έως μέτρια συσχέτιση μεταξύ της ελληνικής έκδοσης του δείκτη Short-WORC και του δείκτη Rand-36 Item Health Survey ($r=0,30-0,59$). **ΣΥΜΠΕΡΑΣΜΑΤΑ** Η ελληνική έκδοση της κλίμακας Short-WORC προσφέρεται ως ένα άμεσα εφαρμόσιμο, αξιόπιστο και έγκυρο μέτρο έκβασης για την αξιολόγηση της ποιότητας ζωής των ασθενών με πόνο που σχετίζεται με το στροφικό πέταλο του ώμου. Η περαιτέρω ερευνητική διερεύνηση της ανταποκρισιμότητας της κλίμακας Short-WORC είναι αναγκαία για τη βέλτιστη κλινική εφαρμογή της.

Λέξεις ευρητηρίου: Ερωτηματολόγιο, Μέτρα έκβασης, Πόνος στον ώμο, Στροφικό πέταλο, Ψυχομετρικές ιδιότητες

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