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Scientific/Clinical Article

## Reproducibility: Reliability and agreement of short version of Western Ontario Rotator Cuff Index (Short-WORC) in patients with rotator cuff disorders



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### ABSTRACT

**Introduction:** Recently, a shorter version of Western Ontario Rotator Cuff Index (Short-WORC) was proposed as a subset of 7 items from the original 21-item WORC. However, the reproducibility of the Short-WORC has not been established.

**Purpose of the study:** To determine reproducibility (reliability and agreement) of the Short-WORC among patients with rotator cuff disorders (RCDs).

**Methods:** Patients ( $n = 153$ ) diagnosed with RCD completed the WORC at baseline and at 3 months post-operatively ( $n = 146$ ). The Short-WORC was extracted from the full version of WORC. From this retrospective cohort, 43 patients were retested within 5 weeks, if they remained stable. Cronbach's alpha ( $\alpha$ ) and intra class correlation coefficients ( $ICC_{2,1}$ ) were used to assess internal consistency and test-retest reliability respectively. Standard error measurement (SEM), minimal detectable change (MDC90) and Bland Altman (BA) plots were used to assess agreement.

**Results:** No floor and ceiling effects were reported for either the Short-WORC or WORC. Cronbach's  $\alpha$  were 0.84 and 0.90 at baseline and 0.89 and 0.95 at 3 month of follow up for Short-WORC and WORC respectively. The  $ICC_{2,1}$  were 0.89 and 0.91 for the Short-WORC and WORC respectively. The agreement parameters for the Short-WORC were: SEM<sub>agreement</sub> = 8.8, MDC90<sub>individual</sub> = 20.3, MDC90<sub>group</sub> = 5.1. We found substantial agreement between the two versions of WORC on BA plots with minimal (mean difference ( $d$ ) < 1) systematic differences between them. The limits of agreement (LOA) between two versions of WORC were similar across sessions and fell within range of -11.7 to 13.2 points at test and -14.7 to 14.7 points at retest.

**Conclusion:** Short-WORC and WORC demonstrates strong reproducibility and can be used for group and individual comparison of health-related quality of life (HRQoL) among patients with RCD. Wider LOA may be expected when using the Short-WORC for individual patient assessment. Reproducibility data is essential, but should be supplemented by validation of actual Short-WORC with samples representing the spectrum of RCD.

**Level of evidence:** N/A.

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### Background

Rotator cuff disorders (RCDs) are the most common cause of shoulder pain, impairment and activity limitation which contributes to substantial disability and loss of quality of life (QoL).<sup>1–3</sup> The prevalence of partial and full-thickness rotator cuff tears is greater than 60% in symptomatic patients over 60 years old<sup>4</sup> and

approximately 40% of asymptomatic patients over 50 years old have full-thickness tears.<sup>5</sup> The conservative and surgical treatment in patients with RCDs, primarily aims at improving function and QoL.<sup>6,7</sup>

Measurement of health-related quality of life (HRQoL) is useful to guide treatment, determine prognosis and evaluate treatment outcomes in patients with shoulder pain.<sup>8</sup> Self-reporting is necessary to estimate the HRQoL.<sup>6,8–10</sup> Reliable and valid patient-reported HRQoL measures are needed to evaluate the effectiveness of treatment from the perspective of the patient.<sup>7,11</sup> Previous systematic reviews addressing patient-reported outcome measures (PROs) in people with shoulder problems indicated a lack of sufficient evidence and the best measure to evaluate the effectiveness of treatment could not be identified.<sup>12–16</sup> However, a recent systematic review that focused on PROs specific to RCD concluded that Western Ontario Rotator cuff Index (WORC) is the most responsive PRO for the patients with RCD.<sup>17</sup>

The 21-item WORC is among the most studied and well reported disease-specific PRO used for the assessment of HRQoL in patients with RCD.<sup>6,18–20</sup> The WORC has been translated and validated in a number of languages including German, Dutch, Japanese, Turkish, Brazilian, Persian, and Norwegian.<sup>21–30</sup> However, there are several challenges when using the WORC, including the complexity of administering visual analogue scales, the lack of validation of the subscale structure, response burden and gaps in the validation of the WORC. Recently, a shorter version of WORC (Short-WORC) was developed that resulted in a brief scale with a single summary score.<sup>31</sup> By shortening the original 21-item WORC, using theoretical and clinical principles supported by a confirmatory factor analysis, a 7-item Short-WORC was developed. The original WORC contained five domains<sup>6</sup> whereas only items from the “work” and “lifestyle” domains were included in the Short-WORC.<sup>31</sup>

Unlike other short measures that expect to retain the conceptual and structural framework of the parent measure, part of the WORC reduction process involved forfeiting the subscale structure. Since these subscales were not validated, this decision may resolve the issue of using un-validated subscales. However, this does mean that the Short-WORC was not designed for equivalence with the WORC total scores. In 2012, Razmjou et al found strong psychometric properties for the Short-WORC and suggested it would reduce the response burden for clinicians, researchers and patients.<sup>31</sup> This study provided preliminary evidence on internal consistency and validity of Short-WORC when compared to the full WORC and other PROs. However, the developers of Short-WORC were not able to determine test-retest reliability and minimal detectable change for the Short-WORC as data from a pre-existing clinical outcome database were used.

It is highly emphasized that measures evaluating the outcomes should be reproducible.<sup>32,33</sup> Reproducibility measures the extent to which similar results can be obtained from repeated assessments in stable subjects.<sup>32–36</sup> Guyatt et al described reproducibility as an umbrella term under which reliability and agreement are distinct parameters.<sup>36,37</sup> According to Standards for Educational and Psychological Testing, reliability is defined as “the degree to which test scores are consistent, dependable, repeatable, that is, the degree to which they are free of errors of measurement (p.93).”<sup>38</sup> Internal consistency (cross-sectional reliability) and test-retest reliability (longitudinal/relative reliability) are the two parameters used to investigate reliability.<sup>33</sup> Agreement is concerned with measurement error and assesses the extent of closeness of scores derived from repeated measurements.<sup>22,39</sup> Absolute reliability coefficients (standard error of the measurement, minimal detectable change) and Bland Altman (BA) plots are commonly preferred methods used to evaluate agreement.<sup>34</sup>

While reliability is necessary for discriminative applications of PRO, agreement is fundamental to making decisions about change

over time in clinical and research settings.<sup>32,36</sup> It is thus important to examine both the reliability and agreement while evaluating measurement properties of outcome measures. Thus, the purpose of our study was to investigate reproducibility (internal consistency, test-retest reliability and agreement) of the Short-WORC in patients with RCDs. Additionally, we aimed to determine if reproducibility characteristics of the shorter 7-item Short-WORC were similar to that of the longer 21-item WORC.

## Methods

We evaluated reproducibility (internal consistency, test-retest reliability and agreement) by reviewing an existing longitudinal cohort database of stable patients ( $n = 153$ ; repeated measure design). These patients were recruited from a surgical wait-list during December 1997 to May 2012 prior to undergoing rotator cuff repair at St. Joseph Hospital, London, Ontario. Ethical approval for the use of existing data available at Roth-McFarlane Hand and Upper Limb Center, London, ON, Canada was obtained from the Health Sciences Research Ethics Board (HSREB) of the University of Western Ontario.

### Sample size calculation

As the WORC has previously shown high test-retest reliability and internal consistency, we expected to obtain test-retest reliability (ICC) of 0.90<sup>40</sup> with Short-WORC (1-tailed 95% confidence interval (CI) width of 0.10). The sample size required to determine whether the reliability of the Short-WORC exceeds 0.80 with an alpha of 0.05 and power of 0.80 was 64 ([Appendix 1](#)).

### Patients

Patients who were aged 18–85 years requiring surgical repair of torn rotator cuff tendons were considered eligible for our study. Patients who underwent arthroscopic rotator cuff repair with or without acromioplasty were included in the study. Patients with a history of previous surgery, upper extremity fracture and other shoulder pathologies such as adhesive capsulitis, shoulder instability, infection, tumors, labral, cartilage and ligamentous tears requiring any additional treatment or surgeries were excluded from the study.

### Sample description and assessment time points

Patients ( $n = 153$ ) with completed individual item scores on Short-WORC and WORC at baseline i.e. a week before surgery ( $n = 153$ ) and at 3 months post-operatively ( $n = 146$ ) were included for analysis of internal consistency. Of these, 44 patients (men 28; women 16; mean age  $60.25 \pm 9.46$ ) who completed the full length of WORC questionnaire twice during their waiting period for rotator cuff repair were eligible for the test-retest reliability study as they were considered stable and were retested within five weeks. We extracted Short-WORC scores from the full length of WORC questionnaire.

### Outcome measures

#### WORC and Short-WORC

The WORC, a patient-reported disease-specific outcome measure used for assessing change in HRQoL in people with rotator cuff pathology was developed in 2003 by Kirkley et al at the University of Western Ontario, Canada.<sup>6</sup> It consists of 21 items presented under 5 domains: physical symptoms (6 items), sports and recreation (4 items), work (4 items), lifestyle (4 items), and emotions (3 items).

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