

# Content reporting of exercise interventions in rotator cuff disease trials: results from application of the Consensus on Exercise Reporting Template (CERT)

Daniel H Major ,<sup>1</sup> Yngve Røe,<sup>1</sup> Margreth Grotle,<sup>1,2</sup> Rebecca L Jessup,<sup>3,4</sup> Caitlin Farmer,<sup>3,4</sup> Milada Cvancarova Småstuen,<sup>1,2</sup> Rachelle Buchbinder<sup>3,4</sup>

**To cite:** Major DH, Røe Y, Grotle M, *et al.* Content reporting of exercise interventions in rotator cuff disease trials: results from application of the Consensus on Exercise Reporting Template (CERT). *BMJ Open Sport & Exercise Medicine* 2019;**5**:e000656. doi:10.1136/bmjsem-2019-000656

Accepted 3 December 2019



© Author(s) (or their employer(s)) 2019. Re-use permitted under CC BY. Published by BMJ.

<sup>1</sup>Faculty of Health Sciences, Oslo Metropolitan University, Oslo, Norway

<sup>2</sup>Research and Communication Unit for Musculoskeletal Health, Oslo University Hospital, Oslo, Norway

<sup>3</sup>Cabrini Institute, Monash Department of Clinical Epidemiology, Melbourne, Victoria, Australia

<sup>4</sup>Monash University Department of Epidemiology and Preventive Medicine, Melbourne, Victoria, Australia

**Correspondence to**  
Dr Daniel H Major;  
danima@oslomet.no

## ABSTRACT

**Background** Exercise interventions are frequently recommended for patients with rotator cuff disease, but poor content reporting in clinical trials of exercise limits interpretation and replication of trials and clinicians' ability to deliver effective exercise protocols. The Consensus on Exercise Reporting Template (CERT) was developed to address this problem.

**Objective** To assess completeness of content reporting of exercise interventions in randomised controlled trials for patients with rotator cuff disease and the inter-rater reliability of the CERT.

**Design** Critical appraisal.

**Methods** Independent pairs of reviewers applied the CERT to all 34 exercise trials from the most recent Cochrane Review evaluating the effect of manual therapy and exercise for patients with rotator cuff disease. We used the CERT Explanation and Elaboration Statement to guide assessment of whether each of the 19-item criteria were clearly described (score 0–19; higher scores indicate better reporting). Percentage agreement and the prevalence and bias adjusted kappa (PABAK) coefficient were used to measure inter-rater reliability.

**Results** The median CERT score was 5 (range 0–16). Percentage agreement was high for 15 items and acceptable for 4 items. The PABAK coefficient indicated excellent (5 items), substantial (11 items) and moderate (3 items) inter-rater agreement.

**Conclusion** The description of exercise interventions for patients with rotator cuff disease in published trials is poorly reported. Overall, the inter-rater reliability of the CERT is high/acceptable. We strongly encourage journals to mandate use of the CERT for papers reporting trial protocols and results investigating exercise interventions.

## INTRODUCTION

Shoulder pain is a prevalent and often long-lasting complaint.<sup>1 2</sup> Presentation for shoulder pain has an incidence of 10 per 1000 in primary care<sup>3 4</sup> and prevalence of 7%–26%.<sup>2</sup> People with shoulder disorders report experiencing pain, physical function/

## Recommendations for future research

- ▶ Evaluate the effect of journal implementation of the Consensus on Exercise Reporting Template (CERT) reporting guideline on the quality of the content reporting of exercise interventions.
- ▶ Determine which CERT items are/are not essential to intervention success in trials investigating the value of exercise.
- ▶ Further refinement and evaluation of use of the CERT to better develop and describe exercise interventions and their important components.

## What is already known?

- ▶ Exercise interventions are recommended as a first-line treatment for people with rotator cuff disease, although there is low-quality evidence that exercise interventions may provide limited benefits.
- ▶ The content reporting of complex interventions, such as exercise interventions, are often poorly reported, which limits interpretation and replication of trials and clinicians' ability to deliver effective exercise protocols where they exist.
- ▶ Early studies have demonstrated that the CERT, developed to address the problem of incomplete reporting of exercise interventions, may be of value for evaluating exercise interventions in musculoskeletal trials.

## What are the new findings?

- ▶ The completeness of content reporting of exercise intervention in randomised controlled trials of trials for people with rotator cuff disease is poor.
- ▶ The CERT is a reliable tool to evaluate the completeness of reporting of exercise interventions in trials.

activity limitations, participation restriction, sleep disruption, cognitive dysfunction, emotional distress and other pathophysiological manifestations (other than pain).<sup>5</sup> The



most common subgroup of shoulder pain is rotator cuff disease,<sup>3,6</sup> an umbrella term for various disorders of the rotator cuff, such as subacromial impingement syndrome, rotator cuff tendonitis or tears, and subacromial bursitis. Exercise interventions have been recommended as a first-line treatment for patients with rotator cuff disease.<sup>7</sup> However, systematic reviews have reported conflicting conclusions about their effectiveness in reducing pain and disability.<sup>8–11</sup>

We know from previous studies that where description of interventions are available, they seldom provide the level of detail required for other researchers to validate trials through replication.<sup>12–18</sup> Inadequate content reporting of interventions also limits the clinician's ability to interpret the study findings and to deliver an effective exercise protocol in their clinical practice,<sup>19</sup> and means it may not be possible to determine which specific components of exercise interventions may be associated with better (or worse) outcomes.<sup>20,21</sup> So far, no studies have been conducted to specifically assess the content reporting of exercise interventions investigated in clinical trials for patients with rotator cuff disease.

In order to improve the content reporting of interventions, the Template for Intervention Description and Replication (TIDieR)<sup>22</sup> checklist was developed. However, this guide was not specifically designed for exercise interventions and does not cover all important exercise prescription domains. The Consensus on Exercise Reporting Template (CERT) was developed to specifically address the problem of incomplete reporting of exercise interventions.<sup>23,24</sup> Based on evidence from a systematic review<sup>12</sup> and subsequent international Delphi consensus study that included 137 experts, it can be used to both review existing published trials of exercise interventions and act as a template when designing and evaluating exercise interventions.<sup>24</sup>

The main objective of this study was to assess the content reporting of exercise interventions in randomised controlled trials (RCTs) for patients with rotator cuff disease by applying the CERT. The secondary objective was to assess the inter-rater reliability of the 19 CERT items.

## METHODS

### Eligibility criteria

We used the recently published 2016 Cochrane Review evaluating the effect of manual therapy and exercise for reducing pain and improving function for patients with rotator cuff disease to identify RCTs for inclusion in this study.<sup>11</sup> Page *et al*<sup>11</sup> included RCTs that compared exercise to placebo, no treatment, usual care or another active intervention among adults ( $\geq 18$  years) with rotator cuff disease. The term 'rotator cuff disease' was used in the review for disorders of the rotator cuff labelled and/or defined by the trial authors using terminology such as subacromial impingement syndrome, rotator cuff tendonitis or tendinopathy, supraspinatus, infraspinatus or subscapularis tendonitis, subacromial bursitis

or rotator cuff tears. Trials could include interventions provided to participants in any setting (eg, outpatient, at home or in the community) and must have involved the prescription of a supervised or unsupervised exercise programme. The intervention could have been with or without the addition of other components (eg, manipulation, lifestyle modification or counselling).

We included 34 exercise trials reported up to March 2015 from Page *et al*'s Cochrane Review.<sup>11</sup>

### Data extraction guidelines

We used previously described data extraction guidelines to standardise the information that was extracted from each included paper.<sup>23</sup> Descriptive data were systematically extracted into a spreadsheet, checked for consistency and merged into one document. In order to ensure a similar understanding of the application of the CERT across five reviewers, all reviewers independently pilot tested the data extraction form using one study, which was not included in the final 34 reviewed. All reviewers discussed their CERT ratings on a video conference in pairs with DHM. We estimated the time of the familiarisation process to be approximately 1.5 hours.

### Application of the CERT

Two reviewers independently scored each included study by applying the CERT.<sup>23</sup> Five reviewers were involved in the application of the CERT (CF, RLJ, YR, MG and DHM). Three reviewers (CF, RLJ and MG) applied the CERT in five trials each; one reviewer (YR) applied the CERT in 19 trials; and another reviewer (DHM) applied the CERT in all included trials. The CERT includes 16 categories and 19 separate items considered essential in the reporting of reproducible exercise interventions listed under seven domains: what (materials), who (provider), how (delivery), where (location), when and how much (dosage), tailoring (what and how) and how well (compliance/planned and actual).<sup>23</sup> The CERT domains include information about any equipment used for exercises, the exercise instructor, core procedural and contextual elements of the exercise intervention that are required for replication, information about participant motivation strategies and whether, and how well, participants complied with the exercise programme.

A more detailed description of the CERT items is available in the Explanation and Elaboration Statement.<sup>23</sup> This statement was used to guide the scope and interpretation of each CERT item. Each CERT item was rated as 'yes' (criterion met, indicating item clearly reported), 'no' (indicating item not reported or not clearly described) or 'unsure', and an overall rating of the exercise description was also made. For no or unsure responses, detailed comments about what was missing or what was unclear were recorded. We summed the number of items rated as yes to compute a total score ranging from 0 to 19 (0=no items clearly described to 19=all CERT items clearly described).

**Table 1** Description of the included studies

First author, year	Country	Main components of the exercise intervention	Open access	Needed supplementary material
Ainsworth, 2009	England	Stretching exercises, strengthening exercises, posture correction and adaptation of functional activities	Yes <sup>45</sup>	No
Bae, 2011	South Korea	Motor control and strengthening exercises	Yes <sup>37</sup>	No
Baskurt, 2011	Turkey	Standardised flexibility, strengthening and Codman exercises; group II additionally performed scapular stabilisation exercise	No <sup>38</sup>	No
Beaudreuil, 2011	France	Dynamic humeral centring aimed at lowering the humeral head	No <sup>35</sup>	Online appendix (open access)
Bennell, 2010	Australia	Improving dynamic scapular control, strengthening scapular stabiliser and rotator cuff muscles, improving shoulder and thoracic posture and increasing range of motion of thoracic extension	Yes <sup>34</sup>	Protocol paper <sup>71</sup> and online appendix (open access)
Blume, 2015	USA	Eccentric and concentric exercises aiming at optimising rotator cuff and scapular muscle recruitment	Yes <sup>42</sup>	Appendix (open access)
Brox, 1993	Norway	Resistance training of the shoulder rotators and scapular stabilising muscles	Yes <sup>39</sup>	No
Celik, 2009	Turkey	Exercises below or above 90°, T-bar (wand) exercises, posterior capsule stretching and internal rotation exercises and rotator cuff strengthening exercises were performed.	Yes <sup>57</sup>	No
Cloke, 2008	England	Kinetic chain exercises, scapular stabilisation, range of motion exercises, closed chain exercises, plyometric exercises and rotator cuff exercises	No <sup>58</sup>	Kibler 1998 <sup>31</sup> (not open access)
Dickens, 2005	England	Exercises for the recruitment and strength of scapulothoracic muscles and rotator cuff	No <sup>46</sup>	No
Djordjevic, 2012	Serbia	Pendulum exercises and pain-limited, active ROM exercises of shoulder elevation, depression, flexion, abduction, rotations and strengthening exercises. Strengthening exercises were isometric in nature, working on the external shoulder rotators, internal rotators, biceps, deltoid and scapular stabilisers.	No <sup>43</sup>	No
Engebretsen, 2009	Norway	Exercises with a principal focus of relearning of normal movement patterns, which could then be transferred to daily activities	Yes <sup>47</sup>	Böhmer, 1998 <sup>29</sup> (not open access)
Ginn, 2005	Australia	Stretches aimed at lengthening shortened shoulder muscles, exercises aimed at strengthening weakened shoulder muscles, including improving coordination between muscles, and motor retraining aimed at restoring scapulohumeral rhythm during the performance of upper limb tasks	Yes <sup>48</sup>	No
Giombini, 2006	Italy	Pendular swinging in prone position in flexion and extension of the shoulder and passive glenohumeral joint stretching exercises	No <sup>59</sup>	No
Haahr, 2005	Denmark	Exercises aiming at strengthening the stabilisers and decompressors of the shoulder	Yes <sup>49</sup>	No
Hay, 2003	England	Active training of the periscapular muscles and strengthening of the stabilising muscles of the shoulder joint	Yes <sup>50</sup>	No
Holmgren, 2012	Sweden	Strengthening eccentric exercises for the rotator cuff and strengthening concentric/eccentric exercises for the scapula stabilisers	Yes <sup>36</sup>	Online appendix (open access)
Kachingwe, 2008	USA	The exercise programme included posterior capsule stretching, postural correction exercises, and an exercise programme focusing on rotator cuff strengthening and scapular stabilisation	Yes <sup>51</sup>	No
Littlewood, 2014	England	Self-managed loaded exercise using a single exercise	Yes <sup>52</sup>	Development paper <sup>72</sup> (open access)
Lombardi, 2008	Brazil	Strengthening exercises for the shoulder (flexors, extensors, medial and lateral rotators)	Yes <sup>53</sup>	No
Ludewig, 2003	USA	Stretching of the pectoralis minor and for the posterior shoulder, muscle relaxation of the trapezius and strengthening exercises of external rotators and serratus anterior	Yes <sup>60</sup>	No

Continued



Table 1 Continued

First author, year	Country	Main components of the exercise intervention	Open access	Needed supplementary material
Maenhout, 2013	Belgium	Internal and external rotation resisted with an elastic band. The intervention group additionally performed the eccentric phase of full can (thumb up) abduction in the scapular plane with a dumbbell weight	No <sup>61</sup>	No
Martins, 2012	Brazil	Strengthening and stretching exercises were carried out for muscles of the shoulder complex with or without the addition of proprioceptive exercises	Yes <sup>62</sup>	Kuhn, 2009 <sup>32</sup> (not open access)
Marzetti, 2014	Italy	Neurocognitive therapeutic exercises with the aim to teach the patient pathological elements, avoiding compensation and how to rebuild and recover movements in a smooth and functional way. Traditional therapeutic exercise contained strengthening exercises of the rotator cuff and scapular stabilising muscles, stretching exercises, Codman's pendulum exercises and exercises with elastic band	Yes <sup>40</sup>	No
Moosmayer, 2014	Norway	Individualised exercise treatment aimed at correction of scapula mal positioning at rest and the restoration of ideal scapula positioning and centring of the humeral head during movement	Yes <sup>54</sup>	A Norwegian book* and an appendix
Østerås, 2008	Norway	A combination of aerobic exercises and low-dosage or high-dosage medical exercise therapy	No <sup>63</sup>	No
Rhon, 2014	USA	Exercises directed to the shoulder girdle or thoracic or cervical spine	No <sup>55</sup>	Protocol paper <sup>73</sup> and appendix (open access)
Şenbursa, 2011	Turkey	Range of motion, stretching and strengthening exercises for the rhomboid, levator scapulae, serratus anterior and rotator cuff muscles	No <sup>56</sup>	No
Struyf, 2013	Belgium	Stretching and motor control training of the scapula Exercise therapy comprised of an eccentric muscle strength training programme of the rotator cuff muscles	No <sup>41</sup>	Mottram, 1997 <sup>30</sup> (not open access)
Subasi, 2012	Turkey	Stretching and range of motion exercises followed by land-based or water-based strengthening exercises	No <sup>64</sup>	No
Szczurko, 2009	Canada	Isometric shoulder strength training and a series of passive, active-assisted and active range of motion, muscle strengthening and joint therapy	Yes <sup>65</sup>	Hagberg, 2000 <sup>74</sup> (open access) Levoska, 1993 <sup>33</sup> (not open access)
Walther, 2004	Germany	Exercises aiming at strengthening the depressor muscles and centring the humeral head	No <sup>66</sup>	No
Wang, 2006	USA	Customised exercises designed by the authors to correct different shoulder classification systems	No <sup>67</sup>	No
Winters, 1997	Netherlands	Exercise therapy	Yes <sup>44</sup>	No

\*Not used when assessing the content reporting.

If the authors specifically referred to published protocols, online appendices and supplementary data, the reviewers retrieved and extracted these additional data when relevant. The reviewers also recorded whether the study was published in an open access journal and how easy the intervention description was to access (ie, available in the published paper or required additional data from other sources and, if so, whether this was open access).

Following completion of the review by both reviewers, any disagreements were discussed. If agreement could not be reached, an independent arbiter from the research team was to be consulted.

### Risk of bias assessment

Risk of bias assessments of the included trials, based on the Cochrane Risk of Bias Tool,<sup>25</sup> were taken from the original Cochrane Review.<sup>11</sup> The following domains were assessed: random sequence generation, allocation concealment, blinding of participants and personnel, and blinding of outcome assessment (subjective and objective). The risk of bias figure was prepared using RevMan V.5.3 (The Nordic Cochrane Centre, Copenhagen)

### Inter-rater reliability

Inter-rater reliability of the CERT was assessed for each of the 19 CERT items (including subitems a and b for

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Self-reported outcomes	Blinding of outcome assessment (detection bias)	Objective outcomes	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Ainsworth 2009	+	+	+	+	+	+	+	+	?	+
Bae 2011	?	?	?	?	?	+	+	+	+	+
Baskurt 2011	+	+	?	?	?	+	+	+	?	+
Beaudreuil 2011	+	+	+	+	+	+	+	+	+	+
Bennell 2010	+	+	+	+	+	+	+	+	+	+
Blume 2014	?	+	+	+	+	+	+	+	?	+
Brox 1993	+	?	+	+	+	+	+	+	?	+
Celik 2009	?	?	?	?	?	+	+	+	?	+
Cloke 2008	?	?	+	+	+	+	+	+	+	+
Dickens 2005	?	?	+	+	+	+	+	+	?	+
Djordjevic 2012	+	?	+	?	+	+	+	+	+	+
Engelbrechtsen 2009	+	+	+	+	+	+	+	+	+	+
Ginn 2005	?	?	+	+	+	+	+	+	?	+
Giombini 2006	+	?	+	+	+	+	+	+	+	+
Haahr 2005	+	+	+	+	+	+	+	+	?	+
Hay 2003	+	+	+	+	+	+	+	+	?	+
Holmgren 2012	+	+	+	+	+	+	+	+	+	+
Kachingwe 2008	+	?	+	+	+	+	+	+	?	+
Littlewood 2014	+	+	+	+	+	+	+	+	+	+
Lombardi 2008	+	+	+	+	+	+	+	+	?	+
Ludewig 2003	+	?	+	+	+	+	+	+	?	+
Maenhout 2012	?	?	+	+	+	+	+	+	+	+
Martins 2012	?	?	?	?	?	+	+	+	+	+
Marzetti 2014	+	+	?	?	?	+	+	+	+	+
Moosmayer 2014	+	+	+	+	+	+	+	+	?	+
Osteras 2008	+	+	+	+	+	+	+	+	?	+
Rhon 2014	+	+	+	+	+	+	+	+	+	+
Senbursa 2011	+	?	+	+	+	+	+	+	+	+
Struyf 2013	+	+	?	?	?	+	+	+	+	+
Subasi 2012	?	?	+	+	+	+	+	+	+	+
Szczurko 2009	+	+	+	+	+	+	+	+	?	+
Walther 2004	?	?	+	+	+	+	+	+	+	+
Wang 2006	?	?	+	+	+	+	+	+	?	+
Winters 1997	+	+	+	+	+	+	+	?	?	+

**Figure 1** Risk of bias summary: Cochrane Review of authors' judgements about each risk of bias item for each included study. Empty cells mean that objective outcomes were not measured in the trial, so an assessment of the risk of bias due to lack of blinding of such outcomes was not applicable.

items 7, 14 and 16) using percentage agreement<sup>26</sup> and the prevalence and bias adjusted kappa (PABAK) coefficient.<sup>27</sup> While kappa statistics measures chance-adjusted agreement and is therefore more robust than simple percentage agreement, when the prevalence of one of the categories is much higher than that of the other, chance agreement will be high and kappa can have unexpectedly low values.<sup>26–28</sup> For percentage agreement, a score of 70% or greater is considered acceptable and  $\geq 80\%$  is considered high.<sup>28</sup> For PABAK coefficients, the strength of agreement is interpreted as follows: 0=poor, 0.01–0.20=slight, 0.21–0.40=fair, 0.41–0.60=moderate, 0.61–0.80=substantial and 0.81–1=excellent.<sup>28</sup>

## Data analysis

Data were entered into SPSS V.22 and were analysed using descriptive statistics and narrative summaries. For each study, the total CERT score was presented together with the percentage of a maximum CERT score of 19. The bootstrapped median was calculated using STATA (Version 12. College Station, TX, United States of America). Bootstrapping is a statistical method based on simulation of random sampling from the available data. We have performed 10 000 repetitions of the sampling creating samples with the same statistical properties as the original data set. The estimate of the median and 95% CI were calculated directly from the simulated repeated sampling. In this way, we did not have to assume any statistical distribution for the median and achieved a higher level of precision when constructing the CI.

## RESULTS

Twenty of the 34 trials were open access articles (table 1). The trials were from 15 different countries, and the main components of the exercise interventions most often included strengthening, scapula stabilising, stretching and 'corrective' exercises. Twelve trials referred specifically to supplementary material, and five of these were not open access.<sup>29–33</sup> Of the included trials, three<sup>34–36</sup> were judged to be at low risk of bias; eight trials<sup>37–44</sup> were at unclear risk of bias; and 23 trials<sup>45–67</sup> were at high risk of bias (figure 1).

### Final consensus CERT results

The CERT evaluation of the reporting of the exercise interventions of the 34 included trials is shown in table 2. The median score was 5 (range 0–16) out of a possible score of 19. Six trials had a CERT score of  $\geq 10$ , while the remaining 83% (18/34) all scored  $< 10$ , indicating that the majority of the details of the exercise interventions was missing from the trial reports. The bootstrapped median with 10 000 bootstrap samples indicated a median CERT score of 5 (95% CI 3.5 to 6.1).

Four CERT items were clearly described by at least 50% of the trials (figure 2). These included description of any non-exercise component (23 trials), whether the intervention was supervised or not supervised (21 trials), if the intervention included a home programme (17



**Table 2** Results of application of the Consensus on Exercise Reporting Template to each included trial and total number (%) of items fulfilling criteria of acceptable reporting by final consensus

First author, year	1. Exercise equipment	2. Instructor qualifications	3. Individual or group supervised or not supervised	5. Adherence	6. Motivation	7.a. Progression rule	7.b. Progression description	8. Exercise description	9. Home programme	10. Non-exercise components	11. Adverse events	12. Setting	13. Intervention details	14. Generic or individually tailored	14.b. Tailored (how)	15. Starting level rule	16.a. Adherence (planned)	16.b. Adherence (actual)	Total number (%) of items fulfilling criteria
Ainsworth, 2009 <sup>45</sup>	1	0	0	0	0	1	1	0	0	1	0	1	0	1	0	0	0	0	6 (32)
Baskurt, 2011 <sup>38</sup>	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	2 (11)
Baskurt, 2011 <sup>38</sup>	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	3 (16)
Beaudreuil, 2011 <sup>35</sup>	0	0	1	0	0	0	1	1	1	1	0	1	1	1	0	0	0	1	10 (53)
Bennell, 2010 <sup>34</sup>	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	0	16 (84)
Blume, 2015 <sup>42</sup>	1	0	1	0	0	1	1	1	1	0	0	0	0	1	1	1	0	0	9 (47)
Brox, 1993 <sup>39</sup>	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	4 (21)
Celik, 2009 <sup>57</sup>	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	3 (16)
Cloke, 2008 <sup>58</sup>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0 (0)
Dickens, 2005 <sup>46</sup>	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	5 (26)
Djordjevic, 2012 <sup>43</sup>	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	3 (16)
Engelbrechtsen, 2009 <sup>47</sup>	0	0	1	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	6 (32)
Ginn, 2005 <sup>48</sup>	0	0	1	0	0	1	0	0	1	1	0	1	0	1	0	0	0	0	6 (32)
Giombini, 2006 <sup>59</sup>	1	0	1	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	5 (26)
Haahr, 2005 <sup>49</sup>	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	2 (11)
Hay, 2003 <sup>50</sup>	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	3 (16)
Holmgren, 2012 <sup>36</sup>	1	0	1	1	0	0	1	1	1	1	0	1	1	1	1	0	0	0	11 (58)
Kachingwe, 2008 <sup>51</sup>	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	4 (21)
Littlewood, 2014 <sup>52</sup>	1	0	0	1	1	1	1	1	0	1	0	1	1	1	1	1	0	1	12 (63)

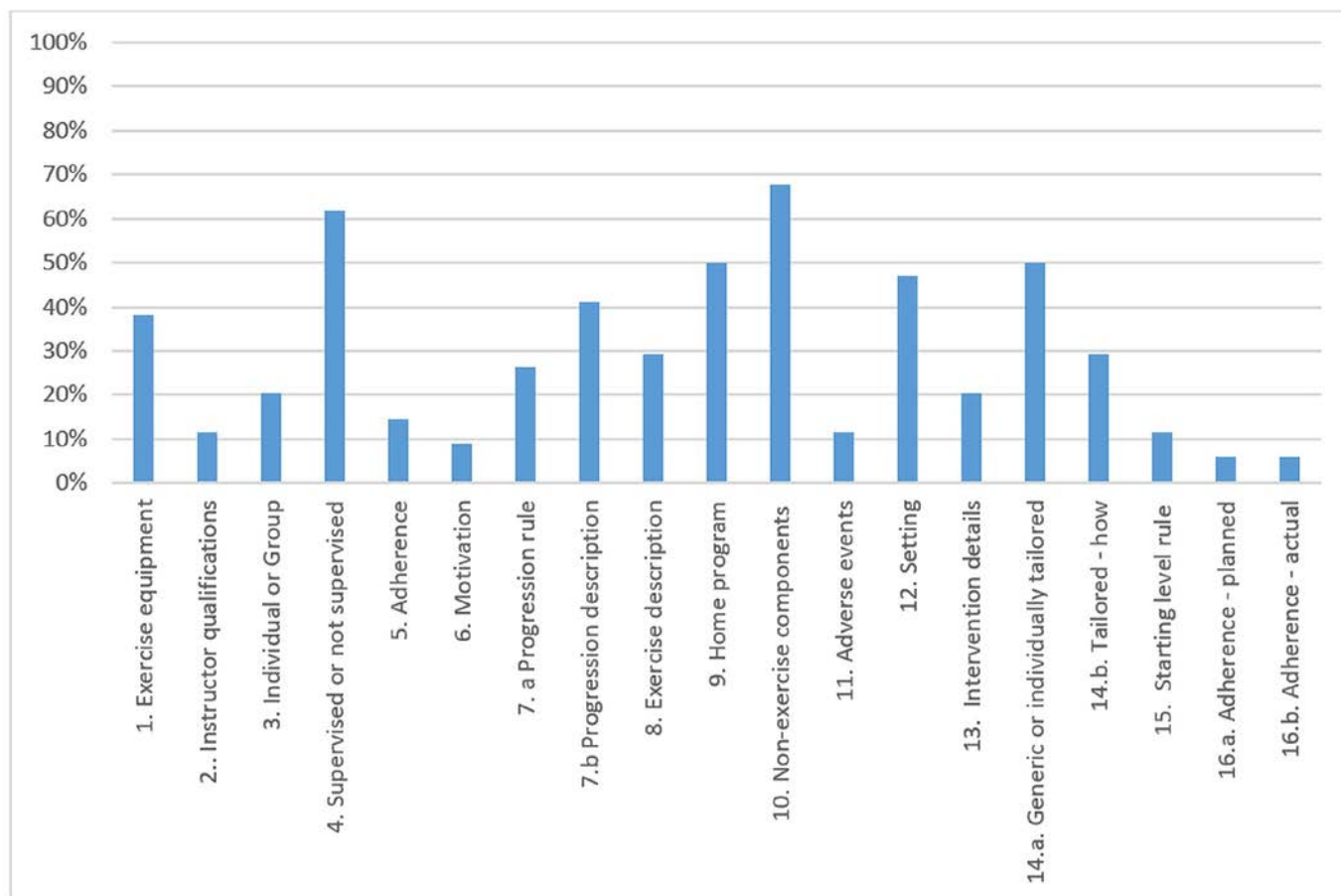
Continued



Table 2 Continued

First author, year	1. Exercise equipment	2. Instructor qualifications	3. Individual or group supervised	4. Supervised or not supervised	5. Adherence	6. Motivation	7.a. Progression rule	7.b. Progression description	8. Exercise description	9. Home programme	10. Non-exercise components	11. Adverse events	12. Setting	13. Intervention details	14.a. Generic or individually tailored	14.b. Tailored (how)	15. Starting level rule	16.a. Adherence (planned)	16.b. Adherence (actual)	Total number (%) of items fulfilling criteria
Lombardi, 2008 <sup>53</sup>	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	4 (21)
Ludewig, 2003 <sup>60</sup>	1	0	0	1	0	0	1	1	1	1	0	0	0	0	1	1	0	0	0	8 (42)
Maenhout, 2013 <sup>61</sup>	1	0	0	1	0	0	1	1	1	1	1	0	0	1	1	1	0	0	0	10 (53)
Martins, 2012 <sup>62</sup>	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1 (5)
Marzetti, 2014 <sup>40</sup>	1	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	0	0	0	5 (26)
Moosmayer, 2014 <sup>54</sup>	0	0	0	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	5 (26)
Østeras, 2008 <sup>63</sup>	1	0	1	1	0	1	0	1	0	0	0	0	0	0	1	1	1	0	0	7 (37)
Rhon, 2014 <sup>55</sup>	1	1	0	0	0	0	0	0	1	1	1	1	1	0	1	0	0	1	0	10 (53)
Şenbursa, 2011 <sup>56</sup>	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	3 (16)
Struyf, 2013 <sup>41</sup>	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	2 (11)
Subasi, 2012 <sup>64</sup>	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	3 (16)
Szczurko, 2009 <sup>65</sup>	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2 (11)
Waather, 2004 <sup>66</sup>	1	0	0	1	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	7 (37)
Wang, 2006 <sup>67</sup>	0	0	0	1	1	0	1	0	0	0	0	0	1	0	1	1	0	0	0	7 (37)
Winters, 1997 <sup>44</sup>	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2 (11)
<b>Total</b>	<b>13 (38)</b>	<b>4 (12)</b>	<b>7 (21) (62)</b>	<b>21 (62)</b>	<b>5 (15)</b>	<b>3 (9)</b>	<b>9 (26)</b>	<b>14 (41)</b>	<b>10 (29)</b>	<b>17 (50)</b>	<b>23 (68)</b>	<b>4 (12)</b>	<b>16 (47)</b>	<b>7 (21)</b>	<b>17 (50)</b>	<b>10 (29)</b>	<b>4 (12)</b>	<b>2 (6)</b>	<b>2 (6)</b>	<b>2 (6)</b>

CERT, Consensus on Exercise Reporting Template.



**Figure 2** Percentage of interventions (out of 34) with complete reporting for each of the Consensus on Exercise Reporting Template checklist.

trials), and whether it was generic or individually tailored (17 trials). The following items were particularly poorly reported across most trials: motivational strategies were described in only three trials (9%)<sup>34 52 63</sup>; how adherence or fidelity was assessed/measured was reported in only two trials (6%)<sup>34 55</sup>; and to what extent the intervention was delivered as planned was reported in only two trials (6%).<sup>35 52</sup>

### Inter-rater agreement of CERT assessment

Table 3 presents percentage agreement and PABAK coefficients for each CERT item. For a majority of the items, inter-rater agreement was high according to percentage agreement (15/19 items: >80%) and it was substantial (11 items: 0.61–0.80) or excellent (5 items: 0.81–1.0) according to the PABAK. There was acceptable agreement for the descriptions of the type of exercise equipment (item 1) (74% agreement, PABAK 0.47); qualifications (item 2) (71% agreement, PABAK 0.41); and which setting the exercises were performed (item 12) (79% agreement, PABAK 0.59).

Consensus was reached on all the dissonant items without the need for an independent arbiter. The reason for the disagreements on these items was that one of the reviewers had a stricter interpretation of the CERT Explanation and Elaboration Statement than the other

reviewer (items 1, 2 and 9) and reviewer error (item 12). For item 1 (equipment), the authors had described most of the equipment used, but a detailed description was missing for one or more of the exercises. The disagreement on item 2 (qualifications) was because one of the reviewers rated descriptions such as ‘experienced physiotherapist’, ‘highly experienced physiotherapist’ and ‘musculoskeletal physiotherapist’ as clearly described, while the other reviewer had a stricter interpretation of the item and argued that the description of qualification should also include duration of experience. The seven disagreements on item 12 (setting) was caused by reviewer errors, where the setting had been clearly described in the main paper or the protocol, but one of the reviewers had missed it. For the disagreements other than those that were considered errors, the authors chose to agree on the strictest interpretation in all occasions.

### DISCUSSION

The main result of this paper is that trials investigating exercise interventions designed for patients with rotator cuff disease poorly describe the content of their exercise interventions. Most CERT items were not described in enough detail to be able to be replicated, while only four CERT items were clearly described by at least 50% of the



**Table 3** Percentage agreement and inter-rater reliability for each CERT item

CERT item	% Agreement by item*	Strength of agreement	PABAK kappa coefficient† (95% CI)	Strength of the agreement‡
1. Equipment	74	Acceptable	0.47 (0.29 to 0.76)	Moderate
2. Instructor qualifications	71	Acceptable	0.41 (0.07 to 0.76)	Moderate
3. Individual or group	88	High	0.76 (0.48 to 1.0)	Substantial
4. Supervised or not supervised	88	High	0.76 (0.51 to 1.0)	Substantial
5. Adherence	91	High	0.82 (0.52 to 1.0)	Excellent
6. Motivation	97	High	0.94 (0.47 to 1.0)	Excellent
7a. Progression rule	88	High	0.76 (0.46 to 1.0)	Substantial
7b. Progression description	88	High	0.76 (0.48 to 1.0)	Substantial
8. Exercise description	91	High	0.82 (0.54 to 1.0)	Excellent
9. Home programme	82	High	0.65 (0.38 to 0.92)	Substantial
10. Non-exercise components	82	High	0.65 (0.36 to 0.93)	Substantial
11. Adverse events	91	High	0.82 (0.36 to 1.0)	Excellent
12. Setting	79	Acceptable	0.59 (0.28 to 0.89)	Moderate
13. Intervention details	85	High	0.71 (0.38 to 1.0)	Substantial
14a. Generic or individually tailored	79	Acceptable	0.76 (0.3 to 0.88)	Substantial
14b. Tailored how	88	High	0.76 (0.46 to 1.0)	Substantial
15. Starting level rule	88	High	0.76 (0.34 to 1.0)	Substantial
16a. Adherence (planned)	88	High	0.76 (0.7 to 0.83)	Substantial
16b. Adherence (actual)	94	High	0.88 (0.41 to 1)	Excellent

\*For percentage agreement scores, the strength of agreement is expressed by the following descriptors: <70%=poor, 70%–79%=acceptable and ≥80%=high.

†Inter-rater reliability measured using the PABAK coefficient.

‡For PABAK scores, the strength of agreement is expressed by the following descriptors: 0=poor, 0.01–0.20=slight, 0.21–0.40=fair, 0.41–0.60=moderate, 0.61–0.80=substantial and 0.81–1=excellent.

CERT, Consensus on Exercise Reporting Template; PABAK, prevalence and bias adjusted kappa.

included trials. Overall, our results also indicate that the inter-rater reliability of the CERT is high/acceptable.

### Comparison with other studies

Our finding of incomplete descriptions of exercise interventions in our corpus of trials is in keeping with previous studies that have evaluated exercise descriptions using the CERT in trials in knee osteoarthritis and a random sample of musculoskeletal exercise trials.<sup>15 17</sup> Comparable findings were also found in a systematic review that assessed the content reporting for exercise interventions for patellofemoral pain syndrome using the TIDieR checklist,<sup>16 22</sup> and Toigo and Boutellier mechanobiological exercise descriptors.<sup>68</sup> In contrast to our study, which included a random sample of rotator cuff disease exercise trials, O'Neil *et al* included only knee osteoarthritis exercise trials that had a Physiotherapy Evidence Database (PEDro) Scale total score of ≥6 out of a maximum of 10.<sup>15</sup> The PEDro score evaluates risk of bias as well as adequacy of trial reporting. Based on the CERT scores of each included study reported in O'Neil *et al*'s supplementary material (appendix 1), we calculated that the included trials had an overall median CERT score of 11 (range 4–17). The higher median score may indicate reporting of exercise interventions is better in higher quality trials.

This is also indicated by our results where the three trials judged to be at low risk of bias were among the six trials with a CERT score of ≥10. A post hoc analysis, requested by a reviewer, also revealed a statistically significant ( $p=0.026$ ), weak positive correlation (Spearman's  $r=0.38$ ) between the CERT score and the number of low bias items on the Cochrane risk of bias tool. Other possible explanations for the higher CERT score could also be that the content reporting of exercise interventions in trials for people with knee osteoarthritis are generally better than trials for people with rotator cuff disease, or that O'Neil *et al* were less strict when applying the CERT.

Overall, we determined that the inter-rater reliability of the CERT was high/acceptable by two different agreement measures, and this is keeping with the recently published study by Slade *et al*.<sup>17</sup> However, there are some minor differences across studies for some specific items. We found acceptable/moderate agreement for the CERT item concerning qualifications (item 2), whereas Slade *et al*<sup>17</sup> reported high/excellent inter-rater reliability for this item. This may have been due to lack of clarity that duration of experience is an important consideration, and this needs to be made explicit in the CERT. Slade *et al*<sup>17</sup> reported poor/fair inter-rater reliability for item



14b (tailored—how) and item 15 (starting rule), whereas we reported high/substantial inter-rater reliability for the same items. The better reliability of these latter items in our study is likely explained by the clarification of how these items should be assessed following the study by Slade *et al.*<sup>17</sup>

### Strengths and limitations

A strength of our study was the use of an internationally endorsed reporting guideline for assessing the completeness of descriptions of exercise interventions in clinical trials. The CERT has previously been shown to be user-friendly and time-efficient for review purposes.<sup>17</sup> In order to ensure similar interpretation of the CERT items, we pilot tested the extraction form for familiarisation purposes before assessing the included trials. We assessed a sample of rotator cuff disease trials investigating the value of exercise from a recent Cochrane Review. This ensured that the included studies were relevant and important for the shoulder research field. Since all the included studies were published prior to the CERT or TIDier, this study reflects the practice of content reporting of exercise interventions without any influence of the new intervention reporting recommendations. Finally, the inter-rater agreement may also have been overestimated due to the small sample size of 34 and the precision of the PABAK estimates, which might have been higher with more studies.

### Implications for practice

To be able to interpret, use, or replicate the research, published reports need to include a sufficiently clear, complete and accurate description of the intervention.<sup>18</sup> If clinicians, patients and policy makers are to implement the latest evidence from systematic reviews and/or trials, they need to be able to access clearly described interventions that include all the necessary detail about the specific components of an exercise programme. Our results indicate that only 2 of 34 trials reported whether the intervention was delivered as planned, and only 5 trials reported how they assessed/measured adherence. Not reporting these items hinders accurate interpretation of trial findings, as the reader does not know if the patients/therapists did more/less than what was described in the intervention and/or if the participants adhered to the exercise intervention. Incomplete reporting is also challenging for meta-analysis, which may lead to inappropriate pooling of data from heterogeneous interventions and, in worst case scenarios, erroneous conclusions.

### Implications for research

Detailed description of each CERT item would enable researchers to conduct further research in order to identify which items are (or are not) significantly associated with the outcome (eg, Does the qualification of the instructor matter?). This could inform future exercise interventions.<sup>69</sup> Trial authors should be obliged

to provide a detailed description of their intervention either in the primary paper reporting their results or in a protocol paper. Where further details are provided elsewhere, it is important that these are available via open access and that links remain unbroken over time. The use of the CERT has the potential to advance this field for researchers, peer reviewers, policymakers and clinicians by facilitating an unambiguous description of exercise programmes, which would ultimately lead to less research waste and more timely uptake of evidence into practice.<sup>70</sup>

### CONCLUSION

The completeness of content reporting of exercise interventions in RCTs of trials for people with rotator cuff disease is poor. The CERT is a reliable tool to evaluate the completeness of reporting of exercise interventions in trials. We strongly encourage journals to mandate the use of the CERT when reporting the protocols and results of trials investigating exercise interventions.

**Twitter** Daniel H Major @danielhmajor

**Acknowledgements** RB is supported by an Australian National Health and Medical Research Council Senior Principal Research Fellowship.

**Contributors** RB and DHM conceived the study and all authors contributed to its design and content. DHM, YR, MG, RLJ and CF conducted the review of the included studies. DHM and MCS conducted the data analysis. DHM wrote the first draft of the article. All authors contributed to the revisions of the article. All authors have read and approved the final manuscript.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** RB was the senior investigator and guarantor for the development of the CERT.

**Patient consent for publication** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request.

**Open access** This is an open access article distributed in accordance with the Creative Commons Attribution 4.0 Unported (CC BY 4.0) license, which permits others to copy, redistribute, remix, transform and build upon this work for any purpose, provided the original work is properly cited, a link to the licence is given, and indication of whether changes were made. See: <https://creativecommons.org/licenses/by/4.0/>.

### ORCID iD

Daniel H Major <http://orcid.org/0000-0001-5204-162X>

### REFERENCES

- 1 Croft P, Pope D, Silman A. The clinical course of shoulder pain: prospective cohort study in primary care. primary care rheumatology Society shoulder Study Group. *BMJ* 1996;313:601–2.
- 2 Luime JJ, Koes BW, Hendriksen IJM, *et al.* Prevalence and incidence of shoulder pain in the general population; a systematic review. *Scand J Rheumatol* 2004;33:73–81.
- 3 Ostör AJK, Richards CA, Prevost AT, *et al.* Diagnosis and relation to general health of shoulder disorders presenting to primary care. *Rheumatology* 2005;44:800–5.
- 4 van der Windt DA, Koes BW, de Jong BA, *et al.* Shoulder disorders in general practice: incidence, patient characteristics, and management. *Ann Rheum Dis* 1995;54:959–64.
- 5 Page MJ, O'Connor DA, Malek M, *et al.* Patients' experience of shoulder disorders: a systematic review of qualitative studies for the OMERACT Shoulder Core Domain Set. *Rheumatology* 2019;58:1410–21.
- 6 Linsell L, Dawson J, Zondervan K, *et al.* Prevalence and incidence of adults consulting for shoulder conditions in UK primary care; patterns of diagnosis and referral. *Rheumatology* 2006;45:215–21.

- 7 Haik MN, Albuquerque-Sendin F, Moreira RFC, *et al.* Effectiveness of physical therapy treatment of clearly defined subacromial pain: a systematic review of randomised controlled trials. *Br J Sports Med* 2016;50:1124–34.
- 8 Littlewood C, Ashton J, Chance-Larsen K, *et al.* Exercise for rotator cuff tendinopathy: a systematic review. *Physiotherapy* 2012;98:101–9.
- 9 Steuri R, Sattelmayer M, Elsig S, *et al.* Effectiveness of conservative interventions including exercise, manual therapy and medical management in adults with shoulder impingement: a systematic review and meta-analysis of RCTs. *Br J Sports Med* 2017;51:1340–7.
- 10 Saltychev M, Äärilä V, Virolainen P, *et al.* Conservative treatment or surgery for shoulder impingement: systematic review and meta-analysis. *Disabil Rehabil* 2015;37:1–8.
- 11 Page MJ, Green S, McBain B, *et al.* Manual therapy and exercise for rotator cuff disease. *Cochrane Database Syst Rev* 2016;1.
- 12 Slade SC, Keating JL. Exercise prescription: a case for standardised reporting. *Br J Sports Med* 2012;46:1110–3.
- 13 Hoffmann TC, Erueti C, Glasziou PP. Poor description of non-pharmacological interventions: analysis of consecutive sample of randomised trials. *BMJ* 2013;347.
- 14 Abell B, Glasziou P, Hoffmann T. Reporting and replicating trials of exercise-based cardiac rehabilitation: do we know what the researchers actually did? *Circ Cardiovasc Qual Outcomes* 2015;8:187–94.
- 15 O'Neil J, McEwen D, Del Bel MJ, *et al.* Assessment of the content reporting for therapeutic exercise interventions among existing randomized controlled trials on knee osteoarthritis. *Clin Rehabil* 2018;32:980–4.
- 16 Holden S, Rathleff MS, Jensen MB, *et al.* How can we implement exercise therapy for patellofemoral pain if we don't know what was prescribed? A systematic review. *Br J Sports Med* 2018;52:385.
- 17 Slade SC, Finnegan S, Dionne CE, *et al.* The consensus on exercise reporting template (CERT) applied to exercise interventions in musculoskeletal trials demonstrated good rater agreement and incomplete reporting. *J Clin Epidemiol* 2018;103:120–30.
- 18 Glasziou P, Altman DG, Bossuyt P, *et al.* Reducing waste from incomplete or unusable reports of biomedical research. *The Lancet* 2014;383:267–76.
- 19 Glasziou P, Meats E, Heneghan C, *et al.* What is missing from descriptions of treatment in trials and reviews? *BMJ* 2008;336:1472–4.
- 20 Hanratty CE, McVeigh JG, Kerr DP, *et al.* The effectiveness of physiotherapy exercises in subacromial impingement syndrome: a systematic review and meta-analysis. *Semin Arthritis Rheum* 2012;42:297–316.
- 21 Littlewood C, Malliaras P, Chance-Larsen K. Therapeutic exercise for rotator cuff tendinopathy: a systematic review of contextual factors and prescription parameters. *Int J Rehabil Res* 2015;38:95–106.
- 22 Hoffmann TC, Glasziou PP, Boutron I, *et al.* Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ* 2014;348:g1687.
- 23 Slade SC, Dionne CE, Underwood M, *et al.* Consensus on exercise reporting template (CERT): explanation and elaboration statement. *Br J Sports Med* 2016;50:1428–37.
- 24 Slade SC, Dionne CE, Underwood M, *et al.* Consensus on exercise reporting template (CERT): modified Delphi study. *Phys Ther* 2016;96:1514–24.
- 25 Higgins JPT, Altman DG, Gøtzsche PC, *et al.* The Cochrane collaboration's tool for assessing risk of bias in randomised trials. *BMJ* 2011;343:d5928.
- 26 de Vet HCW, Terwee CB, Knol DL, *et al.* When to use agreement versus reliability measures. *J Clin Epidemiol* 2006;59:1033–9.
- 27 Chen G, Faris P, Hemmelgarn B, *et al.* Measuring agreement of administrative data with chart data using prevalence unadjusted and adjusted kappa. *BMC Med Res Methodol* 2009;9:5.
- 28 Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977;33:159–74.
- 29 Bohmer AS, Staff PH, Brox JI. Supervised exercises in relation to rotator cuff disease (impingement syndrome stages II and III): a treatment regimen and its rationale. *Physiother Theory Pract* 1998;14:93–105.
- 30 Mottram SL. Dynamic stability of the scapula. *Man Ther* 1997;2:123–31.
- 31 Kibler WBEN. Shoulder rehabilitation: principles and practice. *Med Sci in Sports Exerc* 1998;30:40–50.
- 32 Kuhn JE. Exercise in the treatment of rotator cuff impingement: a systematic review and a synthesized evidence-based rehabilitation protocol. *J Shoulder Elbow Surg* 2009;18:138–60.
- 33 Levoska S, Keinänen-Kiukaanniemi S. Active or passive physiotherapy for occupational cervicobrachial disorders? A comparison of two treatment methods with a 1-year follow-up. *Arch Phys Med Rehabil* 1993;74:425–30.
- 34 Bennell K, Wee E, Coburn S, *et al.* Efficacy of standardised manual therapy and home exercise programme for chronic rotator cuff disease: randomised placebo controlled trial. *BMJ* 2010;340:c2756.
- 35 Beaudreuil J, Lasbleiz S, Richette P, *et al.* Assessment of dynamic humeral centering in shoulder pain with impingement syndrome: a randomised clinical trial. *Ann Rheum Dis* 2011;70:1613–8.
- 36 Holmgren T, Björnsson Hallgren H, Öberg B, *et al.* Effect of specific exercise strategy on need for surgery in patients with subacromial impingement syndrome: randomised controlled study. *BMJ* 2012;344.
- 37 Bae YH, Lee GC, Shin WS, *et al.* Effect of motor control and strengthening exercises on pain, function, strength and the range of motion of patients with shoulder impingement syndrome. *J Phys Ther Sci* 2011;23:687–92.
- 38 Başkurt Z, Başkurt F, Gelecek N, *et al.* The effectiveness of scapular stabilization exercise in the patients with subacromial impingement syndrome. *J Back Musculoskelet Rehabil* 2011;24:173–9.
- 39 Brox JI, Staff PH, Ljunggren AE, *et al.* Arthroscopic surgery compared with supervised exercises in patients with rotator cuff disease (stage II impingement syndrome). *BMJ* 1993;307:899–903.
- 40 Marzetti E, Rabini A, Piccinini G, *et al.* Neurocognitive therapeutic exercise improves pain and function in patients with shoulder impingement syndrome: a single-blind randomized controlled clinical trial. *Eur J Phys Rehabil Med* 2014;50:255–64.
- 41 Struyf F, Nijs J, Mollekens S, *et al.* Scapular-focused treatment in patients with shoulder impingement syndrome: a randomized clinical trial. *Clin Rheumatol* 2013;32:73–85.
- 42 Blume C, Wang-Price S, Trudelle-Jackson E, *et al.* Comparison of eccentric and concentric exercise interventions in adults with subacromial impingement syndrome. *Int J Sports Phys Ther* 2015;10:441–55.
- 43 Djordjevic OC, Vukicevic D, Katunac L, *et al.* Mobilization with movement and kinesiotaping compared with a supervised exercise program for painful shoulder: results of a clinical trial. *J Manipulative Physiol Ther* 2012;35:454–63.
- 44 Winters JC, Sobel JS, Groenier KH, *et al.* Comparison of physiotherapy, manipulation, and corticosteroid injection for treating shoulder complaints in general practice: randomised, single blind study. *BMJ* 1997;314:1320–5.
- 45 Ainsworth R, Lewis J, Conboy V. A prospective randomized placebo controlled clinical trial of a rehabilitation programme for patients with a diagnosis of massive rotator cuff tears of the shoulder. *Shoulder Elbow* 2009;1:55–60.
- 46 Dickens VA, Williams JL, Bhamra MS. Role of physiotherapy in the treatment of subacromial impingement syndrome: a prospective study. *Physiotherapy* 2005;91:159–64.
- 47 Engebretsen K, Grotle M, Bautz-Holter E, *et al.* Radial extracorporeal shockwave treatment compared with supervised exercises in patients with subacromial pain syndrome: single blind randomised study. *BMJ* 2009;339:b3360.
- 48 Ginn KA, Cohen ML. Exercise therapy for shoulder pain aimed at restoring neuromuscular control: a randomized comparative clinical trial. *J Rehabil Med* 2005;37:115–22.
- 49 Haahr JP, Østergaard S, Dalsgaard J, *et al.* Exercises versus arthroscopic decompression in patients with subacromial impingement: a randomised, controlled study in 90 cases with a one year follow up. *Ann Rheum Dis* 2005;64:760–4.
- 50 Hay EM, Thomas E, Paterson SM, *et al.* A pragmatic randomised controlled trial of local corticosteroid injection and physiotherapy for the treatment of new episodes of unilateral shoulder pain in primary care. *Ann Rheum Dis* 2003;62:394–9.
- 51 Kachingwe AF, Phillips B, Sletten E, *et al.* Comparison of manual therapy techniques with therapeutic exercise in the treatment of shoulder impingement: a randomized controlled pilot clinical trial. *J Man Manip Ther* 2008;16:238–47.
- 52 Littlewood C, Malliaras P, Mawson S, *et al.* Self-managed loaded exercise versus usual physiotherapy treatment for rotator cuff tendinopathy: a pilot randomised controlled trial. *Physiotherapy* 2014;100:54–60.
- 53 Lombardi I, Magri AG, Fleury AM, *et al.* Progressive resistance training in patients with shoulder impingement syndrome: a randomized controlled trial. *Arthritis Rheum* 2008;59:615–22.
- 54 Moosmayer S, Lund G, Seljom US, *et al.* Tendon repair compared with physiotherapy in the treatment of rotator cuff tears: a randomized controlled study in 103 cases with a five-year follow-up. *J Bone Joint Surg Am* 2014;96:1504–14.
- 55 Rhon DI, Boyles RB, Cleland JA. One-Year outcome of subacromial corticosteroid injection compared with manual physical therapy for the management of the unilateral shoulder impingement



- syndrome: a pragmatic randomized trial. *Ann Intern Med* 2014;161:161–9.
- 56 Şenbursa G, Baltacı G, Atay Ö Ahmet. The effectiveness of manual therapy in supraspinatus tendinopathy. *Acta Orthop Traumatol Turc* 2011;45:162–7.
- 57 Celik D, Akyüz G, Yeldan I. [Comparison of the effects of two different exercise programs on pain in subacromial impingement syndrome]. *Acta Orthop Traumatol Turc* 2009;43:504–9.
- 58 Cloke DJ, Watson H, Purdy S, et al. A pilot randomized, controlled trial of treatment for painful Arc of the shoulder. *J Shoulder Elbow Surg* 2008;17:S17–21.
- 59 Giombini A, Di Cesare A, Safran MR, et al. Short-Term effectiveness of hyperthermia for supraspinatus tendinopathy in athletes: a short-term randomized controlled study. *Am J Sports Med* 2006;34:1247–53.
- 60 Ludewig PM, Borstad JD. Effects of a home exercise programme on shoulder pain and functional status in construction workers. *Occup Environ Med* 2003;60:841–9.
- 61 Maenhout AG, Mahieu NN, De Muynck M, et al. Does adding heavy load eccentric training to rehabilitation of patients with unilateral subacromial impingement result in better outcome? A randomized, clinical trial. *Knee Surg Sports Traumatol Arthrosc* 2013;21:1158–67.
- 62 Martins LV, Marziale MHP. Assessment of proprioceptive exercises in the treatment of rotator cuff disorders in nursing professionals: a randomized controlled clinical trial. *Rev Bras Fisioter* 2012;16:502–9.
- 63 Østerås H, Arild Torstensen T, Arntzen G, et al. A comparison of work absence periods and the associated costs for two different modes of exercise therapies for patients with longstanding subacromial pain. *J Med Econ* 2008;11:371–81.
- 64 Subasi V, Toktas H, DÜ S, et al. Water-Based versus land-based exercise program for the management of shoulder impingement syndrome. *Turk J Phys Med Rehabil* 2012;58:79–84.
- 65 Szczurko O, Cooley K, Mills EJ, et al. Naturopathic treatment of rotator cuff tendinitis among Canadian postal workers: a randomized controlled trial. *Arthritis Rheum* 2009;61:1037–45.
- 66 Walther M, Werner A, Stahlschmidt T, et al. The subacromial impingement syndrome of the shoulder treated by conventional physiotherapy, self-training, and a shoulder brace: results of a prospective, randomized study. *J Shoulder Elbow Surg* 2004;13:417–23.
- 67 Wang SS, Trudelle-Jackson EJ. Comparison of customized versus standard exercises in rehabilitation of shoulder disorders. *Clin Rehabil* 2006;20:675–85.
- 68 Toigo M, Boutellier U. New fundamental resistance exercise determinants of molecular and cellular muscle adaptations. *Eur J Appl Physiol* 2006;97:643–63.
- 69 Hoffmann TC, Oxman AD, Ioannidis JP, et al. Enhancing the usability of systematic reviews by improving the consideration and description of interventions. *BMJ* 2017;358.
- 70 Kent P, O'Sullivan PB, Keating J, et al. Evidence-Based exercise prescription is facilitated by the consensus on exercise reporting template (CERT). *Br J Sports Med* 2018;52:147–8.
- 71 Bennell K, Coburn S, Wee E, et al. Efficacy and cost-effectiveness of a physiotherapy program for chronic rotator cuff pathology: a protocol for a randomised, double-blind, placebo-controlled trial. *BMC Musculoskelet Disord* 2007;8:86.
- 72 Littlewood C, Malliaras P, Mawson S, et al. Development of a self-managed loaded exercise programme for rotator cuff tendinopathy. *Physiotherapy* 2013;99:358–62.
- 73 Rhon DI, Boyles RE, Cleland JA, et al. A manual physical therapy approach versus subacromial corticosteroid injection for treatment of shoulder impingement syndrome: a protocol for a randomised clinical trial. *BMJ Open* 2011;1:e000137.
- 74 Hagberg M, Harms-Ringdahl K, Nisell R, et al. Rehabilitation of neck-shoulder pain in women industrial workers: a randomized trial comparing isometric shoulder endurance training with isometric shoulder strength training. *Arch Phys Med Rehabil* 2000;81:1051–8.