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Beyond 3 Sets of 10: A Critical Evaluation of the Dosage Parameters Prescribed for Exercise Interventions in Highly Influential Musculoskeletal and Sports Physiotherapy Research

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Abstract

Background Physiotherapists rely on empirical evidence from clinical trials to inform their exercise selection and dosage parameters when prescribing therapeutic exercise. However, protocol descriptions reported in studies are often incomplete to allow full replication, while the dosage parameters that are reported are often inconsistent with the physiological response that the exercise intends to elicit.

Objective To critically evaluate the completeness of the dosage parameters reported for exercise interventions in highly influential musculoskeletal- and sports physiotherapy research, and to assess their potential efficacy based on plausible physiological rationale.

Methods We performed a meta-research study by identifying the 50 most highly cited randomised controlled trials published in quartile 1 (Q1) “Physical Therapy, Sports Therapy and Rehabilitation” journals between 2015 and 2025 investigating any specific exercise intervention intended to treat a musculoskeletal and/or sports-related injury. The Consensus on Exercise Reporting Template (CERT) checklist was used to assess the completeness of exercise parameters reported in each study. The international Consensus on Therapeutic Exercise aNd Training (i-CONTENT) tool was used to assess whether the prescribed dosage parameters were likely to elicit the intended therapeutic response based on plausible physiological rationale.

Results 24% of studies (*k*=12) described their dosage parameters in sufficient detail to enable full replication. Specifically, rest intervals (i.e., time between sets) was the most common parameter omitted (60%), followed by intensity (34%) and tempo (34%). 72% of studies (*k*=36) were considered as ‘high risk’ of ineffectiveness based on a lack of sound rationale to justify the dosage parameters selected for the exercise intervention.

Conclusion These findings highlight substantial concerns regarding both the completeness and rationale for dosage parameters reported for exercise interventions in musculoskeletal- and sports physiotherapy research. Prospective researchers are urged to include information on all key parameters when reporting exercise interventions, and to base their prescription on plausible physiological rationale.

Key Points

- Physiotherapists rely on empirical evidence from clinical trials to inform their exercise selection and dosage parameters when prescribing therapeutic exercise. However, protocol descriptions reported in studies are often incomplete to allow full replication, while the dosage parameters that are reported are often inconsistent with the physiological response that the exercise intends to elicit.
- This is the first study to critically evaluate both the completeness and quality of exercise parameters reported in highly influential musculoskeletal and sports physiotherapy research. Most exercise interventions reported in highly influential musculoskeletal and sports physiotherapy research were considered both incomplete (76%) and unlikely to elicit the intended therapeutic response based on a lack of sound rationale (72%).

- Prospective researchers must include information on all key exercise parameters to allow reproducibility by clinicians and replication by other researchers, ideally with a dosage that is likely to elicit the intended therapeutic response.

1. Introduction

Therapeutic exercise prescription is a mainstay of contemporary practice in musculoskeletal and sports physiotherapy [1]. Clinicians rely on empirical evidence from clinical trials to inform their exercise selection and dosage parameters. However, descriptions of the exact protocols used in studies is not always sufficient to allow full reproducibility in clinical practice [2–4]. Specifically, information on key variables such as intensity and rest intervals between sets are often poorly described or, in some cases, omitted altogether [4, 5]. Such incomplete reporting also limits the ability of other researchers to replicate the findings. Furthermore, what dosage parameters are reported are often inconsistent with the physiological response or adaptation that the prescribed exercise is intended to elicit, thereby undermining its validity [6, 7]. For example, an intervention intended to improve “strength” might consist of three sets of 20 repetitions using a relatively low load.

To address these issues, various reporting guidelines have been developed such as the Consensus on Exercise Reporting Template (CERT) and the International Consensus on Therapeutic Exercise aND Training (i-CONTENT) tool [8]. The CERT, for example, scores the completeness of reporting of exercise interventions in clinical trials. Specifically, it evaluates a study on whether it provides a detailed description of the exercise intervention, including the dosage parameters of key exercise variables. Indeed, to enable reproducibility by clinicians and replication by researchers, trials must report and describe the specific exercise(s), the number of repetitions, sets, rest periods between sets, intensity, frequency, tempo, and duration of the protocol [9]. As such, identifying the key parameters that are most often underreported is needed to improve reporting practices in future trials. Furthermore, the physiological rationale for the specific dosage of a given exercise intervention can only be properly evaluated when all parameters are reported. Considering this, the i-CONTENT evaluates the potential effectiveness of exercise interventions by considering the plausibility that the dosage parameters will elicit the intended adaptations [10]. Used collectively, the CERT and i-CONTENT enable an objective critique of both the completeness and potential effectiveness of exercise interventions reported in clinical trials.

To date, previous reviews have evaluated the overall reporting standards of exercise interventions for specific musculoskeletal and/or sports-related injuries, such as rotator cuff-related shoulder pain [5, 11, 12], shoulder impingement syndrome in overhead athletes [13], and chronic low back pain [14]. While this can help provide insight into the quality of research being conducted in a specific area, it does not allow the evaluation of the state of reporting across the broader musculoskeletal and sports rehabilitation research landscape. Moreover, many of the studies included in these reviews are often published in lower impact journals and may not reflect the literature most used by clinicians to guide their clinical decision making [13–15]. It is possible that evaluating the most influential studies in this field will

provide a more accurate indication of the reporting quality of those studies that impact clinical practice and guide future research.

As such, the current review aims to focus on both the completeness and rationale for the dosage parameters reported in highly impactful trials not limited to a single musculoskeletal and/or sports-related injury. Specifically, the purpose of this review is to evaluate both the quality and descriptions of the exercise parameters reported in the 50 most highly cited studies published in quartile 1 (Q1) physiotherapy-focused journals over the past decade investigating any specific exercise intervention intended to treat a musculoskeletal and/or sports-related injury. By highlighting the key areas that are commonly underreported, we will provide clear recommendations to improve reporting practices to ensure valid and rigorous investigation into the efficacy and effectiveness of exercise-based interventions in the treatment of musculoskeletal and sports-specific injuries.

2. Methods

2.1. Preregistration

The protocol for the current review was preregistered on the Open Science Framework (https://osf.io/e7uxw/).

2.2. Search strategy

Using the subject area “Physical Therapy, Sports Therapy and Rehabilitation,” we searched the Scopus database to identify all quartile 1 (Q1) journals. Scopus primarily ranks journals based on their CiteScore, which counts the number citations received in articles and divides this by the number of publications published over the previous four years. Scopus then sorts all indexed journals within the specific subject area from highest to lowest based on their CiteScore. Q1 captures the journals in the top 25% of this list (see Supplementary File 1 for the full list of Q1 journals identified for the current review).

2.3. Eligibility criteria

Titles and abstracts were then independently screened for every article published from 2015 up to the end of 2024 in each Q1 journal identified in Scopus. Using the Participants, Intervention, Comparators, Outcomes and Study Design (PICOS) framework [16], studies needed to have included the following to be included in the present review:

- (P) adults (≥18 years) who have been diagnosed with a musculoskeletal or sports-specific injury by a registered medical or health practitioner.
- (I) any therapeutic exercise intervention prescribed to ‘treat’ the injury diagnosed by the registered medical or health practitioner.
- (C) comparators can include a comparator exercise intervention, usual care, and/or passive control group.

- (O) given the rationale for this study, all reported primary outcomes will be extracted.
- (S) only experimental (randomised or nonrandomised) study designs will be considered.

Conversely, studies investigating exercise interventions in the following populations were excluded:

- Preventive and/or prophylactic measures (i.e., injury prevention protocols)
- Healthy and non-injured participants (i.e., those who have not been diagnosed with a specific musculoskeletal- or sports-related injury)
- Those with diagnosed medical conditions (i.e., cancer, fibromyalgia)
- General, non-specific, exercises targeting general health outcomes
- Cardiopulmonary rehabilitation
- Neurological rehabilitation
- Acute exercise interventions
- Secondary analyses and follow-up reports of previously published studies
- Research protocols

2.4. Selection process

A list of all articles from each journal that met the inclusion criteria was collated. The authors then identified the top 5 most cited articles in each calendar year from 2015 up to 2024, based on mean citations reported between Scopus and Google Scholar, resulting in a total of 50 studies for evaluation. This ensured the articles examined were highly influential, and more likely have impacted current practice in musculoskeletal- and sports physiotherapy over the past 10 years [17].

2.5. Data extraction

Data were extracted by LI using a custom-made Excel spreadsheet. This was then cross-checked for accuracy by HB. The following data were extracted from each study:

a. First author surname
b. Year of publication
c. Article title
d. Study design
e. The purpose of intervention (including the diagnosed musculoskeletal or sports-related injury that the specific exercise intervention intends to ‘treat’)
f. Intervention group and comparator group(s)
g. All primary and secondary outcome measures
h. All parameters reported for the exercise protocol including a list of exercises performed, number of sets, number of repetitions, intensity, rest period between sets, tempo, exercise frequency, intervention duration, and whether progressive overload was used

i. sample size, sample size calculation (if reported), whether the study was preregistered

j. the statistical analysis performed for the primary outcome measure

2.6. Outcomes

The completeness of reporting of exercise parameters reported in all included articles was assessed using the Consensus on Exercise Reporting Template (CERT) with a particular focus on items 8 and 13 [8]. Conventionally, this is scored on a binary scale with "1" for "fully reported" or a "0" for "absent." However, we followed the recommendation proposed by Subialka et al. [5] using a partial-credit method where 0.5 points are awarded for "partial reporting" since scoring in this manner improves precision given the number of parameters required to achieve completeness of reporting.

The therapeutic quality of exercise protocols reported in each article was then assessed using the i-CONTENT tool [10]. Specifically, we focused on item 2 to inform our discussion on the physiological basis for the prescribed exercise intervention (i.e., was the appropriate repetition range and intensity prescribed if the goal was to elicit a maximal strength adaptation?). We were also interested in item 5 to allow a critique of the appropriateness of the outcome measures reported within each study used to determine the effectiveness of the exercise intervention (for example, did the authors use an objective measure of physiological change or simply rely on subjective [unblinded] patient reported outcome measures?).

2.7. Risk of bias

Risk of bias was assessed independently by both authors (LI and HB) using the Standards Method for Assessment of Resistance Training in Longitudinal Designs (SMART-LD) [9]. Given the context of the population groups sampled in the studies included in our review, we modified the criterion for item 4 so that studies were not penalised for not reporting information about the resistance training status of the participants. We considered studies where the primary outcome was self-reported as unblinded to investigators (item 13). For item 15, we only considered whether the proper preparation was employed for the assessment methods of the primary outcome measure. The methodological quality of the included studies was interpreted as good quality (i.e. SMART-LD grade 16–20 [≥80%]), fair (i.e. SMART-LD grade 12–15 [60–79%]) or poor (i.e. SMART-LD grade 0–11 [<60%]).

2.8. Inter-rater agreement

Kappa values were calculated to assess the inter-rater agreement for each item in the i-CONTENT tool and SMART-LD, while linear weighted kappa values were calculated for each item in the CERT. Kappa values were interpreted as almost perfect agreement ($\kappa = 0.81–1.00$), substantial agreement ($\kappa = 0.61–0.80$), moderate agreement ($\kappa = 0.41–0.60$), or slight agreement ($\kappa < 0.20$).

2.9. Statistical analysis

Data are summarised as either mean (±SD) or median (IQR) according to their underlying distribution and presented as frequency distributions either in tabular form or figures. All data analyses were performed in Microsoft Excel ((Microsoft Corporation, Redmond, WA, USA) except for the calculation of kappa statistics and generation of plots, which were calculated using the “irr” and “ggplot2” packages in R, respectively [18, 19].

2.10. Deviations from pre-registered protocol

We initially did not include the i-CONTENT tool in our original research protocol and instead intended to rely on the CERT alone to inform our discussion on the physiological rationale for the exercise parameters prescribed by researchers. However, since the CERT does not contain a dedicated item to scoring this, we opted to also evaluate each included study using the i-CONTENT tool, which has a specific item dedicated to this.

3. Results

3.1. Study characteristics

The 50 studies examined comprised of a total of 3556 participants (65% female [*n* = 2303]), with a mean (± SD) age of 38 (± 14) years (Table 1). A median (IQR) of 59 (42–87) participants were included in each study. The studies investigated 18 specific injuries, the most common of which was chronic low back pain (*k* = 8 [16%]), followed by knee osteoarthritis (*k* = 5 [10%]) and patellofemoral pain (*k* = 5 [10%]). Resistance training was by far the most reported exercise modality (*k* = 27 [54%]), followed by motor control and core stability (*k* = 9 [18%]) and Pilates (*k* = 3 [6%]). Most studies used a patient-reported outcomes as their primary outcome measure (*k* = 30 [60%]). Of these 30 studies, 11 did not include a performance and/or physiological-based secondary outcome measure. Notably, 8 studies (16%) did not explicitly state their primary outcome. A list of all included studies is reported in Supplementary File 2.

3.2. Evaluation of completeness of reporting (CERT)

Using the partial-credit model, the mean (± SD) CERT score across all studies was 9.4 (± 3.4) out of 20. Information about whether the exercises were generic or tailored (item 14a), how each exercise was progressed (item 7b), and detailed descriptions of any home component (item 9) were the items most commonly scored as ‘fully reported’ (70%, 58%, and 54% of studies, respectively), while information about whether the exercises were performed individually or within a group (item 3), detailed descriptions of the expertise of the exercise instructor (item 2b), and detailed descriptions of motivation strategies (item 6) were most often ‘absent’ (82%, 80%, and 72% of studies, respectively) (Figure 1A). The mean CERT score (±SD) across each year is shown in Figure 1B. CERT scores for each item in each study are reported in Supplementary File 3.

Only 24% (*k* = 12) of studies included a complete account of all parameters used in their exercise intervention(s) (item 13), while over half (*k* = 29 [58%]) failed to report this information in sufficient detail.

Rest intervals between each set was the parameter most frequently not reported (*k* = 30 [60%]), followed by both intensity (*k* = 17 [34%]), and tempo (*k* = 17 [34%]) (Figure 1C).

3.3. Evaluation of therapeutic quality (i-CONTENT)

i-CONTENT scores for each item are summarised in Figure 2. 72% of studies (*k* = 36) were deemed to lack a plausible rationale justifying the dosage of the parameters prescribed for their exercise intervention(s) to achieve the intent of the intervention (item 2 – dosage of the exercise programme), while the type and timing of outcome assessment were scored as 'high risk' of ineffectiveness in just under half of the included studies (*k* = 24 [48%]). The i-CONTENT score for each item in each study are reported in Supplementary File 4.

3.4. Risk of bias (SMART-LD)

The risk of bias for the included studies is summarised in Table 2A and reported for each item for each individual study in Supplementary File 5. Eight studies (16%) were considered good quality, 38 studies (76%) as fair quality, while the remaining four studies (8%) were considered poor quality (Table 2B). The main methodological limitations were the lack of reporting of participant adherence (item 7 [86%]), lack of assessor blinding (item 13 [76%), lack of statistical power and/or justification for the sample size (item 3 [74%]) and insufficient description of the exercise intervention to allow replication (item 8 [74%]).

3.5. Inter-rater agreement

Kappa scores for each item of the i-CONTENT tool and SMART-LD, and weighted Kappa scores for each item of the CERT are presented in Table 3. The mean Kappa and mean weighted Kappa scores for the i-CONTENT tool, SMART-LD, and CERT were 0.92, 0.82, and 0.87, respectively, indicating almost perfect agreement. Only two items in the CERT demonstrated less than almost perfect agreement (description of exercises equipment [item 1] and detailed description of any home programme component [item 9]), two items in the i-CONTENT (patient selection [item 1] and dosage of the exercise program [item 2]), and four items in the SMART-LD (random allocation of participants [item 9], concealment of randomisation [item 10], proper preparation of assessment methods [item 15], and replicability of statistical analyses [item 17]).

4. Discussion

The aim of the current study was to identify and appraise both the completeness of the dosage parameters reported for exercise interventions in highly influential musculoskeletal- and sports physiotherapy research, and to assess their potential for effectiveness based on plausible physiological rationale. Overall, only 24% of studies (*k* = 12) described their dosage parameters in sufficient detail to enable replication by clinicians and prospective researchers. Specifically, rest intervals (i.e., time between sets) was the most common variable omitted (60%), followed by intensity (34%) and tempo

(34%). In terms of therapeutic quality, only 28% of studies (*k* = 14) were 'low risk' of ineffectiveness based on sound rationale for the dosage parameters selected for the exercise intervention.

Collectively, these findings highlight substantial concerns regarding both the completeness and rationale for dosage parameters reported in high influential musculoskeletal- and sports physiotherapy research investigating therapeutic exercise interventions. Prospective researchers are urged to include information on all key parameters when reporting exercise interventions, and to base their prescription of these parameters on plausible rationale that matches the physiological response/adaptation they aim to elicit.

4.1. Completeness of reporting

More than half (60%) of included studies failed to report the rest intervals programmed between sets. This is noteworthy, as clinicians and researchers must carefully consider the duration of the rest period between sets that they prescribe since to ensure the desired physiological response and adaptation is elicited. For example, too short a rest period between sets of a plyometric exercise will increase the onset of acute fatigue, compromising the desired intensity and stimulus of subsequent sets [20]. Likewise, a short duration between sets on an exercise programmed to improve strength will reduce the effectiveness of increasing the muscle(s) maximal force generating capacity, rendering subsequent sets less effective [21, 22]. While many clinicians will be able to self-select rest periods based on their own clinical judgment, this is a particular concern in research contexts as it compromises future attempts by researchers to replicate and progress findings.

Intensity was not reported in one-third (34%) of studies. Of the remaining two-thirds (66%), just over half (58%) quantified intensity objectively (i.e., as a % of one repetition maximum [1RM]), while the remaining studies (42%) relied on subjective descriptions (i.e., "the final 3 repetitions being challenging in intensity"). Although the use of subjective descriptors may have strong ecological validity since exercise interventions are often completed unsupervised without quantifiable loads at home, relying on the patient's own perception of their proximity to failure is problematic given that even trained individuals often self-select loads that are too light, grossly overestimating their own proximity to failure [23]. Researchers intending to train using subjective descriptors such as the Rate of Perceived Exertion (RPE) or repetitions in reserve (RIR) should anchor their ratings to a maximal effort set beforehand. However, since the true expression of force generating capacity is often confounded by pain [24], prescribing intensity based on the patient's perception of pain (i.e., with the Visual Analogue Scale [VAS]) might also be appropriate.

More concerning was the fact that one-third of studies failed to provide any useful information regarding the intensity in which their exercise(s) were performed. The intensity at which an exercise is performed has a significant effect on the physiological response and adaptation evoked [25–27]. Failing to report this information substantially undermines the potential effectiveness of what could otherwise be a very sensible exercise selection, contributing to the risk of under- or overdosing. While the former may lead to

an ineffective intervention, the latter has the potential to harm – which reinforces the essential need to report intensity.

Tempo refers to the time taken to complete each repetition within a set of an exercise and is conventionally prescribed as a four-digit sequence (i.e., 40X2) corresponding to the duration (in seconds) of the eccentric phase, isometric pause at the bottom of the movement, concentric phase, and the isometric pause at the top of the movement, respectively. While not universally prescribed, its inclusion in exercise protocols that emphasise the eccentric phase of a movement should be viewed as mandatory as this is a key component of the intervention and will have considerable impact on the perceived intensity of the intervention [28, 29]. For example, performing the eccentric phase of a repetition over 10 seconds will provide a vastly different stimulus compared to performing it over 2 seconds [30, 31]. While the evidence comparing different durations of the eccentric phase on chronic adaptive changes is inconclusive [32–36], researchers should nevertheless quantify this variable to control for overall treatment volume between participants in their study, and to allow clinicians and prospective researchers to replicate their methods. Failure to control for the duration of the eccentric portion in an eccentric-focused exercise protocol threatens the internal validity of the intervention. Surprisingly, information on tempo was reported in two-thirds (66%) of the included studies in the current review. However, of the 9 studies, (18%) that either focused exclusively on or included an eccentric-specific exercise as part of their protocol, only 4 (44%) reported controlling for the duration of the eccentric portion of the exercise. Future research investigating eccentric-focused exercise interventions must report the tempo of at least the eccentric portion of the movement to allow a valid interpretation of the findings.

4.2. Rationale for dosage parameters

Nearly three-quarters (72%) of studies investigated were considered as ‘high risk’ of ineffectiveness based on a lack of plausible rationale to justify the specific dosage parameters prescribed for their exercise intervention(s).

One of the most common limitations observed was the inappropriate use of the term ‘strengthening.’ For example, researchers often prescribed ‘strengthening’ exercises that were inconsistent with the established parameters required to elicit a true strength stimulus. For example, a number of studies prescribed a repetition range that falls outside the optimal window when targeting maximum force generating capacity (i.e., 10 to 20 reps) [37–43], rest periods between sets that were too short (i.e.,≤60 seconds) [40, 41, 44] or not reported at all, performed at too high a frequency (i.e., twice a day) [38, 45–47], and/or failing to report the intensity. Despite some evidence challenging the notion that strength drives recovery in conditions such as rotator cuff-related shoulder pain (RCRSP) [48], these studies are equally susceptible to the very issues outlined in the current review (i.e., 30s rest periods between sets of ‘progressive high load strength training’ exercises [49]; prescribing “strengthening” exercises outside the optimal strength window [50]).

Another related issue was the programming of what could be considered stereotypical 'physiotherapy exercises' prescribed at a generic '3 sets of 10.' While there may be situations where this prescription is suitable, its effectiveness is predicated on the intensity prescribed. These studies commonly failed to report intensity and rest periods, undermining any true effectiveness that a more considered choice of parameters may have otherwise produced. The interaction between intensity and repetition performance needs to be more closely considered and reported in future research to ensure prescriptions are not simply based upon common historical practice.

4.3. How are we measuring effectiveness?

Another important consideration is the type of outcome measures used by researchers to determine the effectiveness of their intervention. A contentious debate revolves around whether self-reported outcome measures are truly 'assessor-blinded' given that the patient is inherently the 'assessor' [51]. This is even more problematic in clinical trials investigating active interventions such as exercise, which are, by their very definition, unfeasible to participant blinding [52]. In essence, studies that rely solely on self-reported outcomes to determine whether their exercise intervention was effective are at higher risk of bias due to their 'double unblinded' design. Eleven studies (22%) in the current review relied solely on self-reported outcome measures, while some included an objective measure that did clearly not reflect the goal or intent of the exercise intervention (i.e., measuring balance when no balance exercises were prescribed nor were balance impairments common within the specific patient group [53]). Inclusion of an objective performance-based outcome measure is critical to determine the efficacy of the exercise intervention itself (i.e., does the exercise actually do what it was intended to do) and can help us better understand the mechanisms underlying any associated changes. This is not to say that self-reported outcome measures are invalid. Indeed, they capture multiple domains that are essential to clinical recovery such as pain, function, and quality of life. However, good research practice should encourage the use of self-reported outcome measures with some objective performance- and/or physiological based measures which capture a response or adaptation that the specific exercise was intended to elicit [54]. Ideally, such objective measures should be assessor-blinded to reduce the risk of bias towards a positive finding.

Given that each study *should* only be sufficiently powered to detect their (ideally a priori) primary outcome, researchers must carefully consider their choice between a measure that more holistically captures the experience of the patient, but is more susceptible to bias, versus one that provides insight into the mechanistic nature of the intervention that is less susceptible to bias, but overlooks the patient's experience. The implication of this decision means that whatever outcomes are designated as secondary will be at greater risk of type II error.

4.4. Risk of bias

The SMART-LD tool used for our risk of bias assessment revealed that a relatively low number of studies that were appropriately preregistered (50%) and the number of studies that either did not provide adequate statistical power or appropriately justify the sample size they recruited (74%). This is noteworthy, as both may suggest the presence of "questionable research practices" (QRPs) within this

body of research. The adoption of QRPs is likely to lead to an increase in the number of type I errors (i.e., false positives) reported in literature, contributing to publication bias and an inability to replicate prior research [55, 56]. Together, these findings may have serious implications for the integrity and trustworthiness of musculoskeletal- and sports physiotherapy research, which has been noted in adjacent fields [57] and future research should consider.

4.5. Comparisons to previous research

Our findings are consistent with those of previous reviews that focused on the completeness of reporting for exercise interventions tailored to specific musculoskeletal injuries [4, 5, 13–15]. However, our investigation into the therapeutic quality of exercise interventions differs somewhat from that of Geraci et al. [6]. Overall, the quality of studies included in their review were rated higher. This may be because their review focused specifically on exercise interventions for those with chronic low back pain. Furthermore, they identified that specific items within the i-CONTENT tool – pertinently, dosage (item 2) and adherence to exercise (item 7) did not achieve satisfactory inter-rater agreement when scored for 'low risk' of ineffectiveness, while none of the items achieved satisfactory inter-rater agreements when for 'high risk' of effectiveness. In comparison, while we achieved similar inter-rater agreement for item 2 ($\kappa = 0.59$ vs. $\kappa = 0.42–0.61$), with the exception of item 1 (patient selection [$\kappa = 0.38$]), our inter-rater agreement for the remaining items was almost perfect ($\kappa = 0.82–1.00$). Lastly, given that each article included at least some information of the dosage parameters used in their exercise interventions, we only scored item 2 (dosage) as either 'low risk' or 'high risk' of ineffectiveness, whereas Geraci et al. scored just under half of their articles as either "probably done" or "probably not done." However, if we consider the percentage of studies considered 'low risk,' then their results (~ 34%) become comparable with the findings of our review.

4.6. Limitations

The current review was by no means exhaustive. However, the intent was never to perform a systematic review – rather, it was to identify the most highly cited studies over the past decade, and by inference, those that have strongly influenced clinical practice and the direction of both current and future research. Moreover, as we only included studies from Q1 journals, it is likely that the included studies are of a higher reporting standard than those that are published in lower quartile journals. As such, it is possible that these issues are representative of the broader topic literature. Secondly, a number of studies included in the current review were published prior to the CERT checklist (2016) and i-CONTENT tool (2021). Nonetheless, Fig. 1B suggests, at most, a negligible increase in mean CERT scores between 2015 and 2024, while there is no discernible change in the therapeutic quality according to the i-CONTENT across the same period. Lastly, there was a slight gender-bias, however, one that was incongruent with that at large within the broader medical research community. Specifically, 65% of participants recruited in the selected studies were female.

4.7. Recommendations for future research reporting

Our findings highlight key areas where reporting needs to improve. Collectively, researchers need to improve their communication and transparency of the parameters prescribed during their exercise interventions. Specifically;

- Information about the rest intervals between sets, intensity, and – especially in the case of an eccentric-focused exercise, tempo of the movement, must be reported to enable prospective researchers to replicate their findings and clinicians to translate them into practice.
- Researchers should base their prescription of each key exercise parameter on sound and plausible physiological rationale and be able to justify their reasoning for doing so.
- The continued use of self-reported outcome measures is strongly encouraged. However, these should be complemented with at least some objective performance and/or physiological measures – ones that are ideally feasible to assessor blinding – to gain a deeper insight into the efficacy of the exercise intervention.

5. Conclusion

The current review reveals the substantial shortcomings in both the completeness and rationale for prescribing specific parameters reported in highly influential musculoskeletal- and sports physiotherapy research investigating exercise interventions. Prospective researchers must transparently report all parameters prescribed in their interventions and ideally justify their reasoning for selecting these variables based on sound and plausible rationale to improve the reproducibility and overall validity of research in this domain.

Abbreviations

Q1 Quartile 1

CERT Consensus on Exercise Reporting Template

i-CONTENT international Consensus on Therapeutic Exercise aNd Training

PICOS Participants, Intervention, Comparators, Outcomes and Study Design

SMART-LD Standards Method for Assessment of Resistance Training in Longitudinal Designs

1RM One repetition maximum

RPE Rate of Perceived Exertion

VAS Visual Analogue Scale

QRPs Questionable research practices

Declarations

Ethics Approval and Consent to Participate Not applicable.

Consent for Publication Not applicable.

Availability of Data and Material The data and materials necessary to reproduce the findings reported in this manuscript are available in the Supplementary Files.

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Authors' Contributions L.I. and H.B. conceptualised the study. L.I. wrote the original draft. H.B. revised the draft and suggested revisions. L.I. extracted the data, which was verified by H.B. L.I. created the tables, and H.B. produced the figures. Quality assessment of included studies was performed independently by L.I. and H.B. Both authors read and approved the final manuscript.

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Tables

Tables 1 to 3 are available in the Supplementary Files section.

Figures

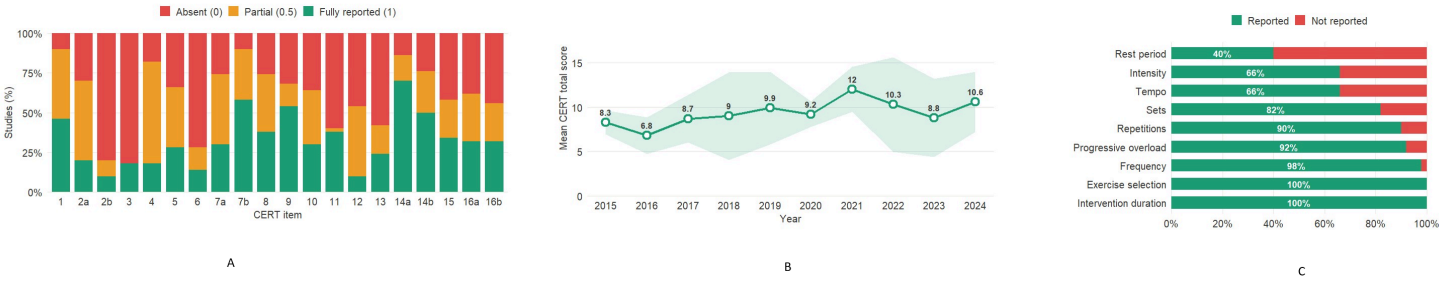

Figure 1

(A) Frequency distribution (%) of Consensus on Exercise Reporting Template (CERT) checklist scores for each item across all included studies (n = 50). (B) Mean CERT checklist score (±SD) of included studies each year from 2015 to 2024. (C) Frequency distribution (%) of specific exercise parameters reported across all included studies (n = 50).

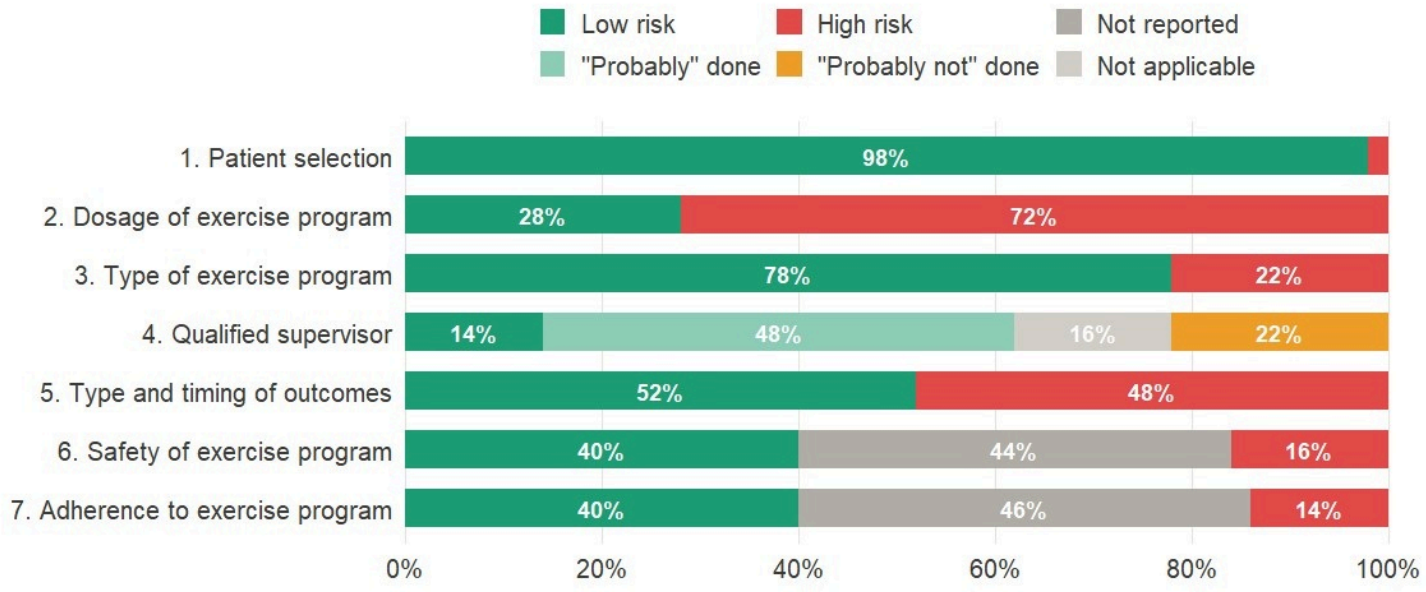

Figure 2

Summary of the therapeutic quality for each item in the international Consensus on Therapeutic Exercise aNd Training (i-CONTENT) tool across all included studies (n = 50).

Supplementary Files

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- Table1.docx
- Table2.docx
- Table3.docx
- SupplementaryInformation.docx
- SupplementaryFile1ListofQ1journals.docx
- SupplementaryFile2Listofincludedstudies.docx
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- SupplementaryFile4iCONTENTratingsforeachstudy.docx
- SupplementaryFile5SMARTLDratingsforeachstudy.docx