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Rehabilitation remodelled: a narrative review of injury rehabilitation models and proposal of a multi-component MSK rehabilitation model

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ABSTRACT
Musculoskeletal injuries are common in both general and sporting populations and contribute to significant healthcare costs, lost workdays and compromised performance of daily activity and sport. Despite various rehabilitation models being available to health and rehabilitation practitioners, there are some inconsistencies in structure, terminology and specificity across these. The current narrative review critically evaluates existing rehabilitation models, frameworks and phased approaches, identifying limitations related to structure, content and specificity. Additionally, a novel multicomponent exercise rehabilitation model is proposed which adopts a non-linear, concurrent approach to attribute development and integration of progression guidance. Using a multicomponent approach, a structured yet adaptable progression framework is provided that could help optimize rehabilitation outcomes, minimize detraining and enhance individuals' readiness for return to sport or daily activity.

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Sports medicine; rehabilitation; injury; return-to-sport

Introduction

In the UK, musculoskeletal (MSK) complaints are the most common conditions seen by physiotherapists (Sephton et al., 2010) and make up 30% of all general practitioner (GP) appointments (NHS England, 2021), with 2405 per 10,000 people being consulted at least once for an MSK problem over the course of a year (Jordan et al., 2010). MSK injuries occur across age ranges, with 17% MSK consultations occurring in 45–64 year olds (Jordan et al., 2010) and nearly half of physically active children (47.3%) between the ages of 9 and 14-years in Scotland and Wales experiencing at least one injury resulting in accident and emergency (A&E) visits (Griffiths et al., 2019). For medically treated injuries in under 17s, the incidence rates vary for different forms of physical activity (PA) across the age ranges: organized sport (0.20–0.67/1000 hours), leisure time PA (0.15–0.17/1000 hours) and physical education (PE) (0.21–2.20/1000 hours) (Nauta et al., 2015). Sport, specifically, seems

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to be the riskiest form of PA for clinically diagnosed injuries (1.57/1000 hours of PA) compared to leisure time PA (0.57/1000 hours) and PE (0.14/1000 hours) (Nauta et al., 2015).

Sporting injuries, specifically, account for 2–3% of GP appointments, with 12–25% of these being for MSK complaints (Baarveld et al., 2010; Jordan et al., 2010). Additionally, MSK sporting injuries make up 2.3–18.3% of all unplanned A&E visits in the UK, with 47.4–52.9% of these being in under 20s (Kirkwood et al., 2019; NHS Digitial, 2012). Differences in reported statistics could be explained by national and regional demographic and physical activity variances.

From an elite sport perspective, reports show injury prevalences of 39%–82% in Olympic athletes from multiple sports, with each Olympian reporting an average of 1.1 injuries during their career (Palmer et al., 2021; Palmer-Green & Elliott, 2014). Professional athletes seem to have higher prevalence rates than their amateur counterparts (46.4% and 38% respectively) (Prieto-Gonzalez et al., 2021), but literature demonstrates the common and prevalent nature of MSK injuries in athletes at all levels of competition.

First-time injuries are not the only concern for medical professionals, with recurrent injury prevalences up to 48% with an incidence rate of 0.5–2.55 injuries per 100 hours (Bitchell et al., 2020). Despite lower prevalences of injury overall, some amateur athletes appear to have higher prevalence of recurrent injuries (Hägglund et al., 2016). Specifically, Hägglund et al. (2016) show that amateur soccer players have higher recurrent injury prevalences (35.1%) when compared to elite and top-level athletes (25.0% and 16.6%, respectively). These findings could be explained by better access to medical provisions and rehabilitation support at the top level of sport (Hägglund et al., 2016), which places more responsibility on the player to self-rehabilitate at lower levels.

Injury recurrence at all levels could be a result of external pressures to return-to-play early from the player themselves, teammates, training partners and coaches (Hägglund et al., 2016; Podlog et al., 2011). Additionally, reinjury occurrences could be also explained by inadequate recovery and strength imbalances on return to play (J.-L. Croisier, 2004a, 2004b; J-L. F. Croisier et al., 2002), which is supported by the findings that meeting return-to-sport criteria is associated with lower reinjury rates (Serner et al., 2020). The reinjury data informs the need for a rehabilitation framework that includes progression guidance and clear goals to ensure that all patient and sport-specific needs are addressed in practice. Such frameworks would facilitate safe, effective and pain-free return-to-sport or daily activity (Kakavas et al., 2021; D. S. Lorenz et al., 2010).

In the context of the current review, the epidemiological data suggests that injuries are common occurrence in both non-sporting and sporting populations. Therefore, the need for efficacious rehabilitation is paramount and we need to continue to optimize rehabilitation guidance for practitioners to ensure both general and athletic populations can consistently and effectively restore function and return to sport, work and daily life.

Impact of MSK injuries: occupational, financial and sporting

Injury has several occupational, financial and sporting implications for individuals and organizations. Reports show that 473,000 workers in the UK suffer from MSK symptoms, which is an increase of 3,000 from the previous reporting period (Health and Safety Executive, 2023). MSK problems are one of the top five reasons for work absence in the

UK accounting for 10.5% absences in 2022 (Office for National Statistics, 2023). Globally, on average, injured individuals have 102 days absent from work with an average income loss of $3,611 (O'Hara et al., 2020), which equates to £2880. In the UK specifically, 185.6 million days are lost due to sickness or injury, with an average of 5.7 days lost per worker (Office for National Statistics, 2023). Additionally, only 58.7%, 67.7% and 60.9% of people suffering orthopaedic injuries return to work after 6, 12 and 24 months, respectively, with 40.5% of people being unemployed 12-months post injury (O'Hara et al., 2020). These figures highlight the scale of the impact MSK issues have on work capabilities and thus personal financial income. From an upstream perspective, the NHS spends over £5 billion annually on treatment and supporting of people with MSK issues (Public Health England, 2019), which further demonstrates the large-scale need to ensure MSK injuries are rehabilitated effectively and efficiently to minimize personal and community-wide burden.

In sport, injuries reduce an athlete's chance of success (Drew et al., 2017), but also the likelihood of them continuing to play in higher leagues and their earning potential (Secrist et al., 2016). From a team perspective, injuries impact player availability and thus reduce chances of club success (Drew et al., 2017), which can result in losses in league points and league position (Eliakim et al., 2020). Specifically, research estimates that for every 136 days lost to injury there is a loss of one league point in the English Premier League. Additionally, player absences due to injury during a season result in an estimated drop of six league places, which translates to approximately £36million loss (Eliakim et al., 2020).

According to the Disablement Model (Vela & Denegar, 2010), MSK injury has several implications for all individuals (Russell et al., 2018; Vela & Denegar, 2010) including impairment (e.g., pain, reduced motion, decreased muscle function), functional limitations (e.g., skill performance and fitness), disability (e.g., participation in leisure, sport and PA) and quality of life (e.g., mood, stress, fear and relationships). These significant effects of injury support the need for consistent and effective rehabilitation programmes to ensure an individual's recovery, function, performance and general wellbeing.

Why remodel rehabilitation? Bridging theory and practice

Constructing and implementing successful injury rehabilitation requires a sound knowledge of the healing process, exercise rehabilitation principles and progression criteria (Futrell & Rozzi, 2020; Järvinen et al., 2005, 2007). Athletic and sporting rehabilitation also requires an understanding of individual athlete needs and sporting demands (Anggiat, 2021; D. Lorenz & Morrison, 2015; Reiman & Lorenz, 2011). Rehabilitation should be structured, progressive and consistent, to address range of motion (ROM), muscular function (e.g., strength and power), neuromuscular abilities (e.g., proprioception and co-ordination) and sport-specific skills (Anggiat, 2021; Kakavas et al., 2021; Reiman & Lorenz, 2011). Aside from restoring function and performance attributes at a specific structure or joint, rehabilitation should also seek to minimize deconditioning of uninjured areas through global loading to ensure a safe and timely return to activity (T. J. Gabbett & Oetter, 2025).

Several models and frameworks exist within the literature that aim to provide a foundation for practitioners to design and implement successful rehabilitation (Anderson & Barnum, 2021; Anggiat, 2021; Houglum et al., 2023). These models offer a range of "phases" and approaches that vary in specificity and context. For example, the models offer variety of goals and approaches, such as broad stages (e.g. repair, function; Caparrós et al., 2017; Draovitch et al., 2022), attribute-specific phases (e.g. ROM and strength; Anderson & Barnum, 2021), exercise types (e.g. compound exercises; Munro, 2023) or context-based loading (e.g. rehab, gym or grass; Mitchell et al., 2023). There is also variation in the structure of existing models moving from a predominantly linear, stepwise, approach (Anderson & Barnum, 2021) to a non-linear, integrated, approach to rehabilitation (Minshull, 2020). The linear approaches organize rehabilitation attributes and goals into sequential stages or "phases", where a specific goal (e.g. ROM) is focussed on and addressed before progressing to the next (Houglum et al., 2023). Non-linear rehabilitation reflects a multicomponent approach whereby attributes and goals are prioritized but are addressed simultaneously (Minshull, 2020).

Alongside theoretical models, existing literature details injury-specific protocols used in practice, such as achilles ruptures (Silbernagel et al., 2020), anterior cruciate ligament injuries (ACL) (M. Buckthorpe et al., 2020; Cooper & Hughes, 2018; Kakavas et al., 2021; Kotsifaki et al., 2023) and hamstring injuries (Aspetar, n.d.; Goom et al., 2016). These protocols, commentaries and case studies draw on experience and practice to provide clinicians with useful applied approaches and ideas when dealing with specific MSK injuries. There is, however, limited reference to any theoretical models of injury rehabilitation (e.g. Anderson & Barnum, 2021). This shows a potential disconnect between theory and practice, which may be due the diversity in the existing theoretical models, and insufficient critical evaluation and updating of these models.

Practitioners can use existing models to design and implement flexible patient or injury-specific rehabilitation plans. The variation, however, requires practitioners to independently choose their foundational approach and then apply these frameworks into their rehabilitation programmes and practice. This leads to diverse rehabilitation approaches in practice. Therefore, there is a rationale to critically review existing models to inform the development of a new model that guides contemporary rehabilitation design and implementation.

Specifically, by collectively exploring the existing models, frameworks and phased approaches, the current review highlights the structural, expressional and specificity-related variations in the existing rehabilitation literature. In doing so, it has informed and integrated the strengths of existing theory into an updated model aimed at practicing health professionals who already possess the required skills, knowledge and experience in MSK rehabilitation. The model provides a non-linear, multicomponent, guide to physical rehabilitation that allows the flexibility to account for patient, injury and sporting variances. An updated model could enhance design consistency and rehabilitation effectiveness, providing a contemporary foundation to optimize return to activity for both athletes and non-athletes.

Review aims

The specific aims of the review are to (a) identify, appraise and integrate existing physical rehabilitation frameworks/models/phases and (b) propose an updated multicomponent exercise rehabilitation model to guide rehabilitation and align theory with applied practice.

Methods

Search process

The current narrative review received ethical approval (ref: 129818) from Leeds Beckett University Research Ethics Sub-committee (URESC). Narrative review methodology was chosen given the breadth of the topic and the lack of primary studies specifically evaluating or testing physical rehabilitation models. The literature was searched by the lead author between March 2024 and March 2025. All other authors reviewed the search process and suggested additional search terms and keywords based on potential omissions. The following databases were used: PubMed, MEDLINE, Cochrane, CINAHL, SportDiscuss. Additionally, the following research search engines were used: Google Scholar and Semantic Scholar. Boolean operators (AND, OR and NOT) and truncations were used to refine the focus of the search. Search terms were grouped based on the aims and focus of the study, and these groups were then combined using the AND Boolean operator as part of the search process. The terms were grouped in relation to the model terminology, the rehabilitation terminology, the injury context and the setting context. Supplementary file A shows the construction of optimal search strings with reasoning, which aimed to capture all relevant literature, whilst keeping the results manageable and specific. The grouping of the terms was as follows:

- Group 1 (model terminology): model OR framework OR continuum OR phase*
- Group 2 (rehabilitation terminology): rehab* OR return OR restor* NOT prevent*
- Group 3 (injury context): injur* OR "musculoskeletal" OR "MSK" OR orthop* OR "injury management" NOT stroke OR cardi* OR COVID OR resp* OR neur*
- Group 4 (setting context): sport OR clinic* AND medicine

Original research articles, reviews, books, chapters and theses were included in the search. Reference lists and other literature, such as textbooks and unpublished work, were also manually reviewed. Textbooks, unpublished work and any grey literature were retrieved via grey literature databases (e.g. MedNar, The King's Fund and OpenGrey), Google search engine, targeted websites, recommendation from experts known to the research team and social media (e.g. LinkedIn). Searching via websites (e.g. Google) and some grey literature databases required a reliance and trust in the search engines relevancy ranking process as it would be impossible to filter all search results (Godin et al., 2015). Additionally, as the vocabulary and search features in grey literature databases and search engines are often different, we adapted the search terms to be compatible with the databases' processes.

The current review sought articles that discussed general physical MSK rehabilitation models, frameworks or phases rather than describing injury-specific protocols or case studies. Specifically, included models needed to detail a full continuum of rehabilitation (e.g. from injury to return to play) and include distinct phases based on specific attributes, goals (e.g. strength and ROM).

Search results: rehabilitation model characteristics

The review process initially yielded 18 models, frameworks or phased approaches. Nine of these models were excluded due to them not presenting or identifying specific attributes but instead offered more generic phases or approaches (see Table 1). Specifically, the models presented general phases or aims, such as early, intermediate, advance stages (Jones & Wilson, 2019), performance improvement (Anemaet & Hammerich, 2014), reconditioning (Draovitch et al., 2022) or early loading and normal movement (Mitchell et al., 2023). Some presented general exercise approaches, such as progressive loading (Joyce & Lewindon, 2016), integrated compound exercises (Munro et al. 2023) or open/closed kinetic chain exercises (Physiopedia, 2009). Although, these are beneficial they rely significantly on the practitioner to set specific attribute goals and were not the focus of the current review.

After excluding nine models, nine were included for the critical review (see Table 2). These models presented a pathway from injury through to a return phase (e.g. return to sport or activity). All nine models also referred to specific attributes across this pathway, such as ROM, strength and proprioception. What follows is a critical discussion of the structural approaches and rehabilitation attributes used in the nine included models.

Critical review of models

Structural approach: the shift from linear to non-linear

Structurally, a predominantly linear approach underpins seven of the models (see Table 2). Although, Comfort and Abrahamson (2010) present a linear approach detailing three phases that combined some concurrent attributes, the overall approach is still largely linear. This assumption of progression through sequential phases reflects a traditional view of rehabilitation as a stepwise resolution of deficits. A linear, stepwise, approach, however, may fail to accommodate the complexity and individuality of patient/athlete needs, sport/activity demands and recovery trajectories in practice (D. S. Lorenz et al., 2010; Reiman & Lorenz, 2011).

In contrast, two contemporary models adopt a non-linear approach that addresses multiple concurrent attributes simultaneously rather than single-focused, sequential stages (Minshull, 2020; Procter et al., 2024). Minshull (2020), specifically, uses the width of arrows to represent the emphasis placed on different attributes at given time points, which offers a dynamic and individualized rehabilitation process. Non-linear approaches to rehabilitation adopt similar principles to multicomponent training (MCT) which, in injury prevention and performance literature, consists of a combination of several attributes, including strength, balance, dynamic stretching, agility, core stability and plyometrics (Brunner et al., 2018; Perez-Gomez et al., 2022; Stojanovic et al., 2023). Despite MCT approaches proving beneficial in injury risk reduction (Brunner et al., 2018; Crossley et al., 2020; Davis et al., 2021; Perez-Gomez et al., 2022; Stojanovic et al., 2023), there is still a paucity of research exploring MCT in sports and MSK rehabilitation.

The linear approach does offer practitioners a clear and systematic phased, stepladder or pyramid approach to rehabilitating their patients or athletes. However, there are some potential drawbacks from a practical perspective to this approach, which could impact the

Table 1. Overview of excluded rehabilitation models and frameworks.

Authors	Date	Rehabilitation Attributes	Literature Type	General Structure	Link
Anemaet & Hammerich	Anemaet and Hammerich (2014)	• Tissue Healing • Mobility • Performance Initiation, Stabilization and Motor Control • Performance Improvement • Advance Skill, Agility and Co-ordination	Research Article	Non-Linear Phases	https://journals.lww.com/topicsingeriatricrehabilitation/abstract/2014/04000/a_framework_for_exercise_prescription.2.aspx
Joyce and Lewindon	Joyce and Lewindon (2016)	• Acute rehabilitation • Progressive loading • Return to training and performance	Book	Linear Phases	https://www.routledge.com/Sports-Injury-Prevention-and-Rehabilitation-Integrating-Medicine-and-Science-for-Performance-Solutions/Joyce-Lewindon/p/book/9780415815062
Caparrós, et al.	2017	• Early mobilisation • Increase functional, intensity, and load • Reach competition level intensity and loading under training condition	Research Article	Linear Phases	https://www.sciencedirect.com/science/article/abs/pii/S1886658117300130
Dhillon et al.	2017	• Acute phase: promote tissue healing and avoid deconditioning • Reconditioning phase • Return to sport • Prevention of reinjury	Research Article	Linear Phases	https://link.springer.com/article/10.4103/ortho.IJOrtho_226_17
Jones & Wilson	Jones and Wilson (2019)	• Early stage • Intermediate stage • Advance stage • Return to sport	Book	Linear Phases	Everyday Sports Injuries by D.K. Publishing | Goodreads
Draovitch et al.	Draovitch et al. (2022)	• Repair • Rehab & Recovery • Reconditioning • Performance • Pre-Season & Training Camp	Research Article	Linear Continuum	https://www.arthroscopysportsmedicineandrehabilitation.org/article/S2666-061X(21)00222-4/fulltext

(*Continued*)

Table 1. (Continued).

Authors	Date	Rehabilitation Attributes	Literature Type	General Structure	Link
Mitchell et al.	Mitchell et al. (2023)	• Phase 1: Diagnosis and Planning • Gym Phase 2: Acute and Contralateral Limb Loading • Gym Phase 3: Early Loading and Normal Movement • Gym Phase 4: Rehab Pathways and Progressions • Gym Phase 5: Gym Exit Profiling • Grass Phase 1: Jogging and Reintroductions • Grass Phase 2: High Speed Running and Change of Direction Drills • Grass Phase 3: Maximum Speed and Positional Drills • Grass Phase 4: Training Transitions	Research Article	Linear Continuum	https://ijspt.scholasticahq.com/article/73317-the-development-of-a-return-to-performance-pathway-involving-a-professional-soccer-player-returning-from-a-multi-structural-knee-injury-a-case-report
Munro, Peil, & Carolan	Munro et al. (2023)	• Isolated Exercise for Injured Tissue • Integrated Compound Exercises • Performance/Functional Exercises • Whole Body Conditioning • Nutrition, Psychology, Lifestyle etc.	Social Media	Non-Linear Continuum	https://www.linkedin.com/posts/allan-munro-1a7a403b_whilst-recently-writing-a-book-chapter-my-activity-7046737811198140416-AiWZ?utm_source=share&utm_medium=member_desktop&rcm=ACoAAC3bAeIBDxVy-IY7uUgtQo1LOc17WqX5m0Y

(Continued)

Table 1. (Continued).

Authors	Date	Rehabilitation Attributes	Literature Type	General Structure	Link
Physiopedia	Physiopedia (2009)	• Protection, Mobilization, Walking • Open/Closed Kinetic Chain Exercises, Proprioceptive, Running • Sport-Specific Drills, Reconditioning • Maintenance, Prevention of Reinjury • Complete Functional Recovery	Website	Linear Phases	https://www.physio-pedia.com/Rehabilitation_in_Sport

Table 2. Overview of included rehabilitation models and frameworks.

Authors	Date	Rehabilitation Attributes	Literature Type	General Structure	Link
Bomgardner	Bomgardner (2001)	• Immobilization • Range of Motion • Strength • Return to Activity	Research Article	Linear Phases	https://journals.lww.com/nsca-scj/citation/2001/12000/rehabilitation_phases_and_program_design_for_the.3.aspx
Stark	Stark (2006)	• Tissue Healing Constraints • Muscle Flexibility and Joint Stability • Muscle Strength, Power, Endurance • Balance and Proprioception • Motor Control and Skill Acquisition • Functional Activity Progression • Return to Sport	Research Article	Linear Pyramid	https://chiromt.biomedcentral.com/articles/10.1186/1746-1340-14-9
Comfort & Abrahamson	Comfort and Abrahamson (2010)	• Injury management: pain, inflammation, healing • Restoration: range of motion, neuro-muscular control • Return to sport: Strength (endurance to max strength), power (dynamic lifts to plyometrics), aerobic capacity	Book	Linear Combined Phases	https://www.wiley.com/en-ae/Sports+Rehabilitation+and+Injury+Prevention-p-9780470985625
Anderson & Barnum	Anderson and Barnum (2021)	• Control Inflammation • Restore Motion • Muscle Strength, Power, Endurance • Return to Sport/Physical Activity	Book	Linear Phases	https://shop.lww.com/Foundations-of-Athletic-Training/p/9781975161378
Buckthorpe & Roi	M. Buckthorpe and Roi (2017)	• Resolve Pain and Inflammation • Restore Range of Motion and flexibility • Restore Strength and Endurance • Restore Motor Control and Co-ordination: Increased focus on Rate of Force Development • Return to Sport and Reconditioning	Research Article	Linear Pyramid	https://pmc.ncbi.nlm.nih.gov/articles/PMC5774916/

(*Continued*)

Table 2. (Continued).

Authors	Date	Rehabilitation Attributes	Literature Type	General Structure	Link
Minshull	Minshull (2020)	• Pain Control • Range of Motion • Function • Gait • Muscle Strength • Rate of Force Development • Sensorimotor Abilities • Performance Sensorimotor Abilities	Book	Non-Linear Hierarchy	https://shop.elsevier.com/books/a-comprehensive-guide-to-sports-physiology-and-injury-management/porter/978-0-7020-7489-9
Anggiat	Anggiat (2021)	• Inflammation control and/or pain management • Restoring range of motion (flexibility) • Increase muscle strength, endurance, agility etc. • Return to sports/physical activity	Research Article	Linear Phases	https://ijmaes.org/2021/09/28/sports-rehabilitation-phases-a-literature-review/
Houglum et al.	Houglum et al. (2023)	• Examination and Assessment and Problems List and Goals List • Correct Deviations and Decrease Pain • Flexibility and Range of Motion • Strength and Endurance • Neuromotor Control and Proprioception • Function • Performance	Book	Linear Pyramid	https://us.humankinetics.com/products/rehabilitation-of-musculoskeletal-injuries-5th-edition-with-hkpropel-online-video?srsltid=AfmBOoq0ClQAv7xthkK9mF6hwDuQCvXbC7UgvQql1dsYHQ0Dd5W-i20z
Procter	Procter et al. (2024)	• Return-to-Function • Strength • Speed & Agility • RFD & Plyometrics • Train-to-Train • Train-to-Compete	Social Media	Non-Linear Continuum	https://www.linkedin.com/posts/lane-procter-a249a0156_my-reflections-as-an-sc-practitioner-through-activity-7254821954338119680-K1Gf?utm_source=share&utm_medium=member_desktop&rcm=ACoAAC3bAeIBDxVy-IY7uUgtQo1LOc17WqX5m0Y

efficacy of the models when used in practice (D. Lorenz & Morrison, 2015). Firstly, the variation in the number of stages in the linear models could create inconsistency and confusion in the delivery of rehabilitation with practitioners potentially using a different number of progressive stages and varied selection and sequence of attribute goals for their patients. A single clinician committing to one approach may not have a significant impact, but if working in a multidisciplinary team (MDT) or multi-clinician setting there may be scope for inconsistency in approaches or phases used, which could impact patient experience, clarity and confusion.

Secondly, by structuring stages in a linear fashion, it could be inferred that patients cannot progress or address other physical attributes until they have completed their current stage. For example, patients may not engage in, or be encouraged to engage in, strength or neuromuscular-related activities until they have achieved a full range of pain-free movement and joint flexibility. This sequencing of attributes could lead to a risk of delayed restoration, or detraining, of these key physical attributes, which could prolong patient recovery and return to activity times (Abbott, 2016; D. Lorenz & Morrison, 2015).

Delayed inclusion of attributes (e.g. strength) is often due to concerns around pain, but pain levels do not necessarily reflect functional capacity. Therefore, pain-free and restricted loading may not be appropriate to develop or maintain local tissue capacity at injured sites (T. J. Gabbett & Oetter, 2025). Specifically, evidence shows rehabilitation with pain-thresholds compared to pain-free limits results in greater recovery of strength and muscle architecture (e.g. fascicle length), with no detrimental effect on RTS times (Hickey et al., 2020). Similarly, including early and progressively loaded strength exercises in rehabilitation reduces return-to-sport (RTS) times without affecting reinjury rates (Bayer et al., 2018), which informs the benefit of integrating concurrent attributes, such as strength, into earlier stages alongside other goals (e.g. ROM). Overall, this evidence suggests that drawing on a concurrent, MCT, approach may be beneficial and could help improve local tissue capacity, such as strength and muscle restoration (Hickey et al., 2020), and result in shorter RTS times (Bayer et al., 2018).

Additionally, evidence demonstrates promising injury risk reduction effects of MCT in multiple team sports, such as soccer and basketball (Brunner et al., 2018; Crossley et al., 2020; Davis et al., 2021; Perez-Gomez et al., 2022; Stojanovic et al., 2023). Specifically, MCT approaches significantly decrease the prevalence of overall injuries (27%) (Crossley et al., 2020) and lower extremity injuries (71%) (Stojanovic et al., 2023). More specifically, MCT warm-ups reduce the prevalence of ACL (45%) (Crossley et al., 2020) and muscle injury (43%) (Perez-Gomez et al., 2022). The positive evidence for injury reduction (Brunner et al., 2018; Davis et al., 2021) could provide a rationale to support the potential shift to an MCT approach in sports injury rehabilitation practices.

Finally, from a psychological perspective, prolonging engagement in singular, sequential, attributes during linear rehabilitation could potentially negatively impact the patient's motivation, boredom and adherence to rehabilitation. Whereas integrating variety, challenge and multiple goal opportunities achieves higher enjoyment and higher rehabilitation commitment (Podlog et al., 2015; Weiss, 2021). Additionally, integrating multiple components with creative and sport or task-specific activities early in rehabilitation could prevent monotony and boredom for the patients and athletes (Weiss, 2021). An MCT approach has been reported to increase general exercise motivation in older, nonathletic, adults (Jofre-Saldia et al., 2023) and perceived readiness and confidence to return to activity or sport (Podlog et al., 2015). A concurrent, MCT approach to rehabilitation may therefore improve an individual's investment and engagement in their rehabilitation, which would help optimize the success and physical outcomes.

Overall, applying a non-linear, MCT, structure, like Minshull (2020) and Procter et al. (2024), could help address some physical and psychological drawbacks of a stepwise approach. An updated MCT model will help practitioners identify, organize and prioritize multiple concurrent key physical attributes during the rehabilitation process, which could help reduce the risk of detraining, optimize an individual's restoration of function and improve their readiness for return-to-sport (RTS) or daily activity and make them more resilient to injury.

Rehabilitation attributes: what and where?

Collectively, the included models include various references to symptom control, ROM, muscle function (e.g. strength, endurance and power), neuromuscular function and performance or sport-related capabilities (see Table 2). There is consistency across most of the models in the early stages, with a focus on symptom control and healing: inflammation control (Anderson & Barnum, 2021; Anggiat, 2021; M. Buckthorpe & Roi, 2017; Comfort & Abrahamson, 2010), pain control (Anggiat, 2021; M. Buckthorpe & Roi, 2017; Comfort & Abrahamson, 2010; Houglum et al., 2023; Minshull, 2020) and tissue healing (Comfort & Abrahamson, 2010; Stark, 2006). There is also consistent reference to restoring available movement at a joint in the initial stage of rehabilitation in all models: range of motion (Anderson & Barnum, 2021; Anggiat, 2021; Bomgardner, 2001; M. Buckthorpe & Roi, 2017; Comfort & Abrahamson, 2010; Houglum et al., 2023; Minshull, 2020) and flexibility (Anggiat, 2021; M. Buckthorpe & Roi, 2017; Houglum et al., 2023; Stark, 2006).

There are, however, some inconsistencies across the models in the order, timing and terminology applied to some attributes (e.g. neuromuscular control and proprioception). Additionally, there is also an overgeneralization and a lack of specificity and differentiation of muscle function attributes (e.g. combining strength, power and muscular endurance) across the models. These inconsistencies in attribute timing, specificity and differentiation could cause confusion and disparity in the design, implementation and efficacy of rehabilitation plans.

Timing and expression of sensorimotor capabilities

With regard to neuromuscular control, proprioception and other sensorimotor capabilities, three models did not have distinct phases that targeted or included these attributes (Anggiat, 2021; Bomgardner, 2001; Procter et al., 2024). Anderson and Barnum (2021) do not have a distinct sensorimotor or neuromuscular stage, but include related attributes throughout stages two, three and four, such as proprioception, balance and coordination. The five remaining models present stages associated with the restoration and enhancement of sensorimotor capabilities (Minshull, 2020), neuromotor or neuromuscular control (Comfort & Abrahamson, 2010; Houglum et al., 2023), motor control (M. Buckthorpe & Roi, 2017; Stark, 2006), coordination (M. Buckthorpe & Roi, 2017), balance (Stark, 2006) and proprioception (Houglum et al., 2023; Stark, 2006). The staging of these attributes across the models, however, is inconsistent in where they are included. The linear models generally introduce specific sensorimotor and neuromuscular attributes in the mid and later stages of rehabilitation (M. Buckthorpe & Roi, 2017; Houglum et al., 2023; Stark, 2006), whereas Minshull's (2020) non-linear model integrates a large focus on sensorimotor capabilities that peaks at the beginning and runs throughout the rehabilitation process with minor reductions in prioritization over time.

The variation in terms and range of sensorimotor-related attributes included in the models could cause confusion and omission of key rehabilitation and RTP markers. Minshull (2020) includes the broader terms "sensorimotor abilities" and a "performance sensorimotor abilities", which allows for the integration of the various aspects of the sensorimotor system (e.g. proprioception and coordination) that help maintain joint homoeostasis and functional (static and dynamic) stability during movement (Fort-Vanmeerhaeghe et al., 2016; Riemann & Lephart, 2002a, 2002b). Using a broader term allows clinicians to use their knowledge to apply an adaptable and flexible integration of the various sensorimotor aspects (e.g. proprioception, balance, coordination and neuromuscular feedback/feedforward) to suit the individual athlete/patient needs for performance and return to activity (Riemann & Lephart, 2002a, 2002b).

Overall, the inconsistency in the models with regard to these attributes may create uncertainty and disparity around the temporal programming and expression of sensory, motor and neuromuscular activities, which are key variables that should be addressed to some degree throughout an individual's rehabilitation rather than just in the later stages. Specifically, the inconsistencies may leave clinicians unsure where to safely and effectively include sensorimotor activities. Also, where specific sensorimotor attributes are used (e.g. co-ordination and proprioception), clinicians may be at risk of having an overly narrow focus and omit other attributes associated with the wider the sensor-neuromuscular system.

Overgeneralising muscle function

All models refer to phases targeting elements of muscle function, with the majority focusing on muscle strength and endurance (Anderson & Barnum, 2021; Houglum et al., 2023). The current review identified some inconsistencies, omissions and overgeneralization in the existing models associated with muscle mass and function. Firstly, despite muscle being the most abundant tissue in the human body (Neumann, 2002) that aids the body's ability to absorb shock and shield other tissues from excessive force (Frontera & Ochala, 2015; MacIntosh et al., 2006), none of the models specifically targeted muscle hypertrophy. Evidence shows that injury results in a reduction in muscle cross-sectional area (CSA) in skeletal muscle (Norte et al., 2018; Perry et al., 2015). Specifically, when athletes are immobilized post-injury there are significant losses in muscle CSA and volume observed (Wall et al., 2014). This evidence highlights the potential for significant reduction in muscle mass post-injury, which informs the need for a specific focus on muscle hypertrophy in early stages after immobilization or inactivity to counteract any muscle atrophy.

Secondly, many existing models seem to not differentiate between types of muscle functions. Muscle function refers to the neural and mechanical attributes involved in human movement (Muscolino, 2017), which broadly include strength, power and endurance. Strength is defined as the ability to voluntarily generate maximal force (Bohannon, 2019; Suchomel et al., 2016). Power is the product of force and velocity or the rate of force development (RFD) and muscle contraction velocity (Ratamess, 2022;

Sapega & Drillings, 1983) and muscular endurance is the ability to sustain muscular activity for prolonged periods of time (Ratamess, 2022). These different functions involve different contractile behaviours, expressions of force quantity, quality, rate, and motor activation patterns (Frontera & Ochala, 2015; Reiman & Lorenz, 2011). Despite muscle function variables being interrelated, for example, higher maximal strength being positively correlated with higher RFD (Haff & Nimphius, 2012; Maffiuletti et al., 2016; Rodríguez-Rosell et al., 2018), the restoration and development of these require individually specific training parameters and to optimize their development (Reiman & Lorenz, 2011).

Despite this need for specificity and differentiation, five of the models (Anderson & Barnum, 2021; Anggiat, 2021; Bomgardner, 2001; Houglum et al., 2023; Stark, 2006) have amalgamated "strength" phases that combine aspects of muscle function (e.g. strength, endurance and power), which could result in an overgeneralization of these attributes when designing a rehabilitation plan. Consequently, the basic principles applied (e.g. sets, reps and tempo) may be too generic to induce specific and targeted adaptations which could impact the conditioning efficacy (Minshull, 2020) and patient/athlete recovery and return to activity outcomes. Three models make some distinction with the inclusion of an RFD attribute (M. Buckthorpe & Roi, 2017; Minshull, 2020; Procter et al., 2024). Similarly, Comfort and Abrahamson (2010) make some differentiation between elements by highlighting a move from endurance to max strength within their strength focus, and a recognition of some nuances within power training (e.g. moving from dynamic lifts to plyometrics). The inclusion of a separate RFD and power focus in four of the models (M. Buckthorpe & Roi, 2017; Comfort & Abrahamson, 2010; Minshull, 2020; Procter et al., 2024) recognizes the physiological and performance-related differences between strength and power and allows for a specific focus on contraction velocity rather than just capacity (e.g. strength and endurance).

Evidence demonstrates the important impact specific and differentiated rehabilitation of muscle functions has on injury recovery, return to activity and reinjury (Angelozzi et al., 2012; Ardern et al., 2011; Turpeinen et al., 2020). For example, a high proportion of injured athletes meet RTP strength criteria and efficiently recover near normal pre-injury strength levels (Angelozzi et al., 2012; Ardern et al., 2011), which suggests strength restoration in rehabilitation is often effective. Despite this effective recovery of maximal strength, return to sport rates are low, reinjury rates are high, and recovery of other muscle functions seems significantly delayed (Angelozzi et al., 2012; Ardern et al., 2011; Hui et al., 2011; Pinczewski et al., 2007). Specifically, RFD recovery in post-operative ACL patients appears to be significantly delayed with asymmetries being present for several years (Angelozzi et al., 2012; Turpeinen et al., 2020). Normal levels of RFD appear to effectively recover when additional, muscle power-related, rehabilitation is completed (Angelozzi et al., 2012), which supports the inclusion of a distinct RFD or muscle power and velocity focus in standard rehabilitation models.

The uniqueness in the training of muscular strength, power and endurance informs a more differentiated and specific inclusion of these into rehabilitation to ensure a safe and effective return to sport or activity (Angelozzi et al., 2012; Reiman & Lorenz, 2011). Ensuring muscle functions are distinguished will optimize the planning and design (e.g. specific goal identification), application of basic principles (e.g. sets, reps and tempo) and identification of performance demands and injury risks, which will help increase overall conditioning efficacy for sport, exercise and health rehabilitation (Minshull, 2020).

Integrating progression into rehabilitation models

Achieving a successful return to activity or sport not only requires optimal structuring and targeting of attributes but also a safe and logical progression within stages and across the rehabilitation timeframe. Progression models exist but are often independent from rehabilitation frameworks, which informed the integration of progression guides into the proposed multicomponent model to provide clinicians with one integrated model to guide their rehabilitation design.

Two models of progression provide a foundation for the current proposed rehabilitation model: the control-chaos continuum (CCC) (Taberner et al., 2019) and the theoretical model for exercise progression (Blanchard & Glasgow, 2014). The control-chaos continuum proposes a five-stage framework that provides a progressive on-field development of running loads and sport-specific activities to optimize an individual's return to play, which has been contextualized in football and basketball (Allen et al., 2021; Taberner et al., 2019, 2023). The CCC draws on intensity increases and the progression of unpredictable, spontaneous, and unanticipated movements and activities that reflect the demands of sport (Taberner et al., 2019). The continuum moves from slower, controlled and linear running to faster, spontaneous and multidirectional running. Additionally, the complexity, technical and musculoskeletal demands, and intensity of sport-specific drills are progressively increased through the phases.

The continuum provides a thorough insight into on-field running and drill-specific progressions which have been applied to both football and basketball as well as specific injures, such as anterior cruciate ligament ruptures and hamstring strains (Allen et al., 2021; Taberner et al., 2019, 2023). Integrating the CCC into an off-field context would allow the principles to be applied to other attributes, such as ROM, strength, power and sensorimotor abilities, providing a progression guide for clinicians.

The theoretical model for exercise progression proposed by Blanchard and Glasgow (2014) can help with the specific progressions of rehabilitation attributes by providing a clear visual aid that highlights the addition and manipulation of extrinsic stimuli and environmental factors to increase skill or exercise difficulty and challenge the intrinsic control of movement and skills (Blanchard & Glasgow, 2014). Like the control-chaos continuum, the theoretical model suggests integrating additional neuro-musculoskeletal demands through increasing the cues, volume of information, and movement and environmental demands at each progressive stage. The model offers a simple layered approach to progression and regression that can be flexible, adaptable and tailored to the needs and demands of the individual. This provides a useful and valuable guide for clinicians and therapy students to apply to rehabilitation practice.

Current limitations to practice

Existing rehabilitation models have provided a foundation for rehabilitation to date, but the large range of resources and the variety they offer in terms of structure and content has some limitations and may explain why current rehabilitation practice may not fully reflect traditional theoretical models or frameworks. Firstly, the predominant linear structure of most existing models could result in a restricted and overly conservative approach, resulting in delayed restoration or detraining for the athlete. Despite, some models presenting a concurrent approach, these are limited in terms of the range of attributes included, which might leave clinicians unsure how to incorporate other key attributes.

Secondly, the variation in order, terminology and differentiation of attributes potentially creates inconsistencies in where, what and how physical component are being targeted at given stages of rehabilitation. Specifically, clinicians may target elements at different stages and/or not be sufficiently specific in the training design depending on their theoretical foundation. This could result in variances in the success and effectiveness of restoring and optimizing some physical attributes, such as sensorimotor capabilities and muscle function.

Finally, having separate progression theory and rehabilitation frameworks requires clinicians to independently find, integrate and apply individual models, which again could result in variances between clinicians' rehabilitation practice in terms of how they develop and progress their rehabilitation programmes.

Remodelling rehabilitation: proposed multicomponent exercise rehabilitation model

The proposed model aims to offer an updated guide for clinicians to design and implement multicomponent, progressive, rehabilitation which bridges a gap between theory and practice. Specifically, the proposed model develops the rehabilitation structure to better reflect current practice. It addresses the potential drawbacks of traditional linear approaches, integrates and advances the consensus of rehabilitation attributes, and overlays a theoretically informed progression guide.

Structural development: applying a non-linear structure

The new model advances existing theory by moving from the traditional linear structure seen in most identified models. Rather than a stepwise, hierarchical, approach, the proposed model presents a horizontal view of rehabilitation that, like Minshull (2020), uses concurrent arrows with varying widths to represent the progressive emphasis on each rehabilitation attribute. The concurrent, multicomponent, approach encourages a simultaneous development of attributes but with progressive changes in priority, which was underpinned by the positive evidence for MCT interventions and their beneficial effects on physical function, injury risk factors, injury prevention, and exercise readiness and motivation (Brunner et al., 2018; Davis et al., 2021; Jimenéz-Rubio et al., 2023; Jofre-Saldia et al., 2023; Podlog et al., 2015). Integrating contemporary approaches (e.g. Minshull, 2020; Procter et al., 2024) and MCT evidence into the proposed model has the potential to help avoid neglect, detraining or regression of attributes, better minimize imbalances and deficits at RTS, optimize patient adherence, motivation and RTS outcomes and reduce reinjury rates.

Updating attributes: optimising timing, terminology and specificity

The proposed model (Figure 1) drew on the consensus of existing models to integrate and optimize the key attributes required for successful physical rehabilitation. The proposed model consists of seven rehabilitation attributes (see Table 3) which includes commonly referenced attributes (e.g. symptom control, ROM), updated attributes (e.g. muscle force capacity, sensorimotor capabilities) and a new attribute (mechanism focused conditioning).

Like many existing models (e.g. Anderson & Barnum, 2021; M. Buckthorpe & Roi, 2017; Minshull, 2020), the proposed model has an early *acute management* stage whereby by the injury it is protected and symptoms are controlled using approaches, such as POLICE (Bleakley et al., 2012) or PEACE (Dubois & Esculier, 2020), followed by an early emphasis on ROM. Unlike existing models (e.g. Anderson & Barnum, 2021; Minshull, 2020), however, ROM focus gradually diminishes but does not fully stop as athletes require maintained ROM and optimal functional movement capabilities for performance and injury risk reduction (Fitton Davies et al., 2022; Knudson, 2012; Witvrouw et al., 2003).

The current model also updates other attributes to address some inconsistencies and clarity issues in existing models, such as the varying expression and staging of sensorimotor characteristics (e.g. co-ordination, proprioception and balance) and the lack of differentiation in muscle-related attributes (e.g. strength, power, endurance and hypertrophy). In existing models, there is a myriad of sensorimotor characteristics, such as proprioception, balance, co-ordination and muscle activation (Anderson and Barnum 2021; M. Buckthorpe and Roi 2017; Houglum et al. 2023; Stark 2006). Attempting to individually highlight each characteristic could make for a complex, busy and confusing model. Consequently, the proposed model, like Minshull (2020), attempts to simplify this by collectively terming these attributes as *sensorimotor capabilities*. Given the target audience for the current review, it would be assumed that the practitioner understands what constitutes sensorimotor capabilities, but Table 3 helps clarify the specific elements. In comparison to most existing model, the focus on sensorimotor capabilities (e.g. muscle activation and proprioception) in the proposed model has been given a relatively high focus throughout as they are key elements that feed into safe and effective movement, muscle function and injury protection/prevention (Clark et al., 2015; Fort-Vanmeerhaeghe et al., 2016; Riemann & Lephart, 2002a, 2002b). The broader term and maintained focus allow the practitioner to be flexible and adaptable in their targeting and progression of specific aspects of sensorimotor capabilities, which would help tailor a periodized, and goal-oriented, approach to suit the patient/athlete sensorimotor needs from early rehabilitation through to RTS.

To address the lack of specificity and differentiation of muscle-related elements in existing models, the proposed model includes three attributes: muscle hypertrophy (restoring and maintaining muscle mass), muscle force capacity (how much and how long for) and muscle force velocity (how fast) (Frontera & Ochala, 2015). By offering a clearer distinction in muscle attributes, the model could optimize the design, development and progression of muscle function attributes during rehabilitation. The focal point for these attributes reflects a common early need to address injury-related atrophy of muscles and to develop an early foundation of strength and endurance (force capacity) to facilitate the progressively increased focus on the individuals' rate of force development

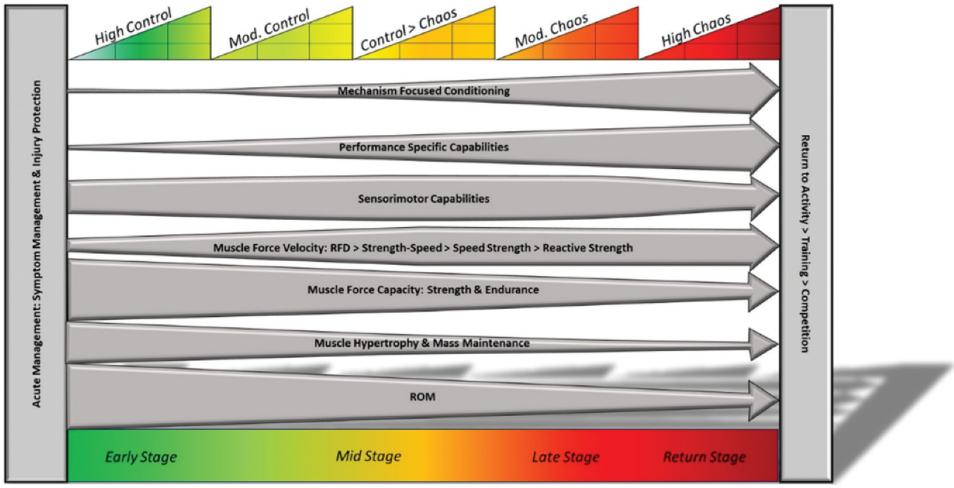

Figure 1. Proposed multicomponent exercise rehabilitation model.

Table 3. Descriptions of the multicomponent exercise rehabilitation model attributes.

Physical Attribute	Description
Range of Movement (ROM)	Restoring and maintaining joint mobility, tissue extensibility and flexibility.
Muscle Hypertrophy & Mass Maintenance	Addressing muscle atrophy and/or maintaining required levels of muscle mass.
Muscle Force Capacity: Strength & Endurance	Restoring and developing muscle ability to generate maximal force and also sustain force production over prolonged periods of time. Can be tailored to athlete current status and injury/sporting needs.
Muscle Force Velocity: RFD, Strength-Speed, Speed-Strength, Reactive Strength	Restoring and developing the muscle ability to generate force quickly with a progressive focus on reducing time to peak force as rehabilitation progresses. Utilising the force velocity curve to structure power-related capabilities.
Sensorimotor Capabilities	Retrain and develop static and dynamic stability, muscle activation and co-contraction, proprioception, balance, co-ordination, reaction time and movement control.
Performance Specific Capabilities	Retrain and develop sport specific skills, return to running, speed, agility, change of direction.
Mechanism Focused Conditioning	Develop resilience, confidence and an ability to cope in vulnerable positions and potential injury mechanism positions.

and power (force velocity) later in the rehabilitation process. Addressing and progressively targeting these muscular attributes will help increase the local tissue capacity and reduce any deficits in these areas which is a key in rehabilitation for restoring specific tissues or region's ability to withstand load and produce force (T. Gabbett et al., 2021).

Rather than a "return to sport" (e.g. M. Buckthorpe & Roi, 2017) or performance (e.g. Houglum et al., 2023) phase, like existing models, the proposed model introduces *performance-specific capabilities* that are progressively integrated throughout. This attribute focus still consists of tasks associated with sports or activity performance and preparation for returns to activity, training, play or competition, such as movement quality, physical conditioning, sport or task-specific skills and reintroduction of training load (M. D. V. Buckthorpe et al., 2019a), but removes the narrow view of sports performance. Removing "sport" allows the practitioner to tailor rehabilitation to any patient guided performance goals (e.g. occupational, daily living and/or sport). As reflected in the existing models and on-field rehabilitation literature (M. D. V. Buckthorpe et al., 2019a, 2019b), the focal point for this element peaks in later stage rehabilitation, but by safely integrating progressive performance-related exercises and activities throughout the rehabilitation process it can help create a balance of local-tissue and sport or task-specific loading, which can optimize the patient and athletes' capacity to safely function in normal daily life and sporting environments (T. J. Gabbett & Oetter, 2025; T. Gabbett et al., 2021). Additionally, including performance-specific activities throughout rehabilitation provides a meaningful context and helps the individual see how specific exercises impact and relate to their activity (sport or daily life), which is valuable for rehabilitation adherence, confidence and reinjury anxiety (Marshall et al., 2012; Podlog et al., 2011).

Finally, the proposed model introduces a novel attribute - *mechanism focused conditioning* - which is not included as an independent goal in any of the previous injury rehabilitation models. Existing on-field, late stage, rehabilitation frameworks and models provide thorough and applied guidance on progressive, sport-specific, reconditioning and RTP preparation (M. D. V. Buckthorpe et al., 2019a, 2019b). These frameworks restore and develop the sport specific load capacity (T. J. Gabbett & Oetter, 2025; T. Gabbett et al., 2021), which can optimize athlete readiness for return to training, play and competition and minimize reinjury risk. Recently, however, Dixon et al. (Dixon et al., 2025) identified the need for a "post-rehabilitation" phase that monitors and continues to train the rehabilitation site (i.e., strength, ROM and movement quality maintenance) with the aim of minimizing any subsequent injuries to the affected or alternative area.

Dixon et al. (2025) work informs the need to continue to optimize any injured site to mitigate reinjury, and the inclusion of mechanism focused conditioning in our prosed model would help form part of this mitigation within the rehabilitation process rather than after. The basis of this attribute was informed by aetiological models of injury and the need to address biomechanical demands and responses associated with inciting events and injury mechanisms (Bahr & Krosshaug, 2005; McIntosh, 2005). Furthermore, injury prevention literature suggests that sports specific injury mechanisms should be a key addition to MCT programmes (Crossley et al., 2020), which rationalizes the inclusion of the proposed attribute in rehabilitation models. Specifically, integrating a controlled replication and conditioning of injury mechanism biomechanics, such as knee valgus or contact scenarios, could help optimize the athletes RTS and re-injury prevention (Bahr & Krosshaug, 2005). The nature of exposing athletes to vulnerable and injury-related movements, events and scenarios means that this peak needed to be later in the model to ensure patient safety and adequate healing. There can be, however, some introductory exercises and activities (e.g. controlled movements associated with the injury mechanism) that can be introduced earlier and may prepare athletes for the more advanced and chaotic mechanism-focused activities (e.g. unanticipated and perturbated movement/forces).

Overlaying progression: integrating control and chaos

To bridge the gap between rehabilitation and progression theory, the proposed model integrates the CCC (Taberner et al., 2019) and the theoretical model for exercise progression (Blanchard & Glasgow, 2014) to aid the advancement of exercises and progression decisions. The layered or undulating progression from control to chaos seen in the proposed model could include changes in planes of movement, joint impact, kinetic chains, movement patterns and speed of movement to alter the stimulus, complexity and unpredictability of the attributes being trained. The specific application of the CCC to specific off-field rehabilitation attributes, however, is beyond the scope of this review and may inform future exploration. Overall, the integration of theories and rehabilitation approaches into one model hopefully provides clinicians with a single guide to not only prioritizing goals, but also how to approach the progression of these goals.

Aligning with current practice: bridging the gap

Despite most of the identified models being linear in their approach, this structure does not seem to be reflected in current practice. Commonly used protocols and guidelines in rehabilitation, such as the Melbourne ACL protocol (Cooper & Hughes, 2018), Aspetar ACL reconstruction (ACLR) guidelines (Kotsifaki et al., 2023) or Aspetar hamstring protocol (Aspetar, n.d.), do present linear stages. These protocols, however, do not implement a rigid, linear, step-wise approach developing attribute but instead integrate and overlap multiple physical components throughout rehabilitation. These programmes work on several attributes, such as ROM, strength, power and sensorimotor qualities, in a concurrent or overlapping approach, which allows a more fluid and criterion-based approach. Through the non-linear, multicomponent approach and inclusion of updated and new attributes, the proposed model builds the existing theoretical approaches to rehabilitation and offers a model that offers a better theoretical reflection current practice, which appears to adopt a more multicomponent, integrated, approach to rehabilitation design and structuring.

Conclusion

The current review identifies that there are a range of models, frameworks and approaches to rehabilitation available to clinicians and rehabilitation practitioners. These theoretical models offer similar messages regarding physical attributes and timing of some key attributes for successful rehabilitation and have served well to guide rehabilitation practice to date. The current review, however, identifies some key observations around the structural approaches, organization and differentiation of physical attributes within existing theoretical models that could create confusion and inconsistency in rehabilitation approaches. Drawing on these observations and strengths of the existing models helped create an evolved model that integrates key rehabilitation attributes in a concurrent and dynamic structure that better aligns with current practice and optimizes consistent rehabilitation design and delivery.

The proposed model provides a foundation for qualified clinicians and practitioners involved in rehabilitation to design, organize and implement progressive, patient-tailored and periodized rehabilitation plans. The model can provide a template that guides a simultaneous, but proportional, focus on multiple attributes across a general rehabilitation continuum which will help with periodization and goal setting. The model, however, can also be adapted by manipulating the arrow widths (i.e., attribute focus) to account for individual needs and injury or tissue-specific requirements. The addition of a progression continuum can help inform the manipulation of complexity and predictability to allow for effective progression of training and rehabilitation activities.

Future qualitative research could explore practitioner and expert views on the utility and applicability of the model in the rehabilitation field. Additionally, there is scope for the model to be empirically tested in longitudinal case–control studies or used in applied case reports, to ascertain the effectiveness of the model in returning injured individuals to sport, daily function or their chosen activities. Similarly, applying the model to different injury cases could allow for the creation and publication of pathology or region-specific iterations of the model. For reader understanding, a hypothetical example of the model in practice is available (supplementary file B). This example provides example exercises from given time points on the model to demonstrate the integration of attributes but is not an exhaustive or full rehabilitation plan. Details of sets, repetitions and loading have been omitted as it was beyond the scope of the current review to debate this contentious issue. Practitioners are encouraged to refer to consult key strength and conditioning and rehabilitation literature for further guidance on selection of micro-variables.

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Abbreviations

ROM	Range of Movement
AROM	Active Range of Movement
PF	Plantarflexion
DF	Dorsiflexion
WB	Weightbearing
PWB	Partial Weightbearing
FWB	Full Weightbearing
INV	Inversion
EV	Eversion
DL	Double Leg
SL	Single Leg
ISO	Isometric
NWB	Non-Weightbearing
DB	Dumbell

BB	Barbell
LAT	Lateral
MED	Medial

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