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# Integrating Physical Rehabilitation with Enhanced Cognitive Behavioural Therapy in Eating Disorders: The Villa Garda Approach

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**Key words**

Eating disorders
Physical rehabilitation
Enhanced cognitive behavior therapy (CBT-E)
Excessive exercise
Malnutrition

**Abstract**

Eating disorders present unique challenges in physical rehabilitation due to the complex interplay between malnutrition-related physical impairments and psychological factors that maintain pathological exercise behaviors. This paper describes therapeutic procedures for integrating physical rehabilitation within an enhanced cognitive behavior therapy (CBT-E) framework for patients with eating disorders in a specialized inpatient setting. The approach addresses both the physical adaptations to malnutrition and the psychological mechanisms that perpetuate excessive exercise. A three-phase progressive model is presented, incorporating systematic assessment protocols, graduated exposure strategies, and real-time monitoring of cognitive and emotional processes during physical activity. The model is designed to restore functional capacity while simultaneously addressing the psychopathological features that maintain the disorder. Clinical implications, current limitations, and future research directions are discussed, with particular emphasis on the potential role of fitness assessment as a therapeutic tool within personalized CBT-E formulation.

## Introduction

The relationship between eating disorders and physical activity is complex and bidirectional. While appropriate physical activity can contribute to recovery [1], excessive or compulsive exercise represents a significant maintaining factor in eating disorders, associated with more extended hospitalizations, lower remission rates, and more rapid relapse following treatment [2,3]. The prevalence of excessive exercise in eating disorder populations ranges from 39% to 48% in adults, reaching up to 80% in patients with restricting-type anorexia nervosa [2,4]. Concurrently, severe malnutrition produces profound physical adaptations affecting multiple physiological systems, including metabolic suppression, cardiovascular changes, musculoskeletal deterioration, and compromised connective tissue integrity [5,6].

Despite the clinical significance of these physical manifestations, current treatment approaches for eating disorders have historically adopted either complete exercise restriction or unsystematic reintroduction protocols. The former, prevalent in the 1970s-1990s, often resulted in high relapse rates and compromised therapeutic alliance [7]. More recent approaches have recognized the need for earlier physical activity reintegration, yet systematic frameworks integrating physical rehabilitation within evidence-based psychological treatment remain limited [8,9].

Enhanced cognitive behavior therapy (CBT-E) has emerged as the leading evidence-based treatment for eating disorders across diagnostic categories and age groups [10,11]. However, standard CBT-E protocols provide limited specific guidance on managing physical activity and restoring functional physical capacity. This represents a



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significant gap, as addressing exercise-related psychopathology and physical rehabilitation requires specialized expertise that typically falls outside the training of CBT-E therapists. At the same time, physiotherapists and exercise specialists often lack the psychological intervention skills necessary to address the cognitive and emotional processes maintaining pathological exercise patterns [12].

This paper describes therapeutic procedures for integrating physical rehabilitation within a CBT-E framework, developed and implemented at Villa Garda Hospital. In this specialized inpatient rehabilitative setting, physiotherapists receive extensive CBT-E training. The approach aims to provide a coherent theoretical and practical framework that addresses both the restoration of physical function and the modification of psychological mechanisms maintaining excessive exercise and body-related pathology.

## Background

### *Physical Adaptations in Eating Disorders*

Severe malnutrition in eating disorders triggers extensive adaptive responses across multiple physiological systems. These adaptations, while initially protective, ultimately contribute to functional impairment and increased medical risk [5,13].

Metabolic adaptations represent the body's primary energy-conservation strategy. Basal metabolic rate may decrease by up to 40% in severe anorexia nervosa, accompanied by reduced thermogenesis and energy expenditure [14]. Cardiovascular changes include bradycardia, hypotension, reduced cardiac mass, and QTc interval prolongation, increasing the risk of cardiac arrhythmias, particularly during refeeding [15]. Endocrine suppression manifests as hypothalamic hypogonadism, reduced thyroid function with low T3 syndrome, and hypercortisolemia, contributing to both metabolic adaptation and mood disturbances [16].

The musculoskeletal system undergoes particularly severe deterioration. Myopathy develops through accelerated muscle catabolism driven by energy deficit and hormonal changes, particularly affecting type II muscle fibres [17,18]. This results in proximal weakness, reduced muscle strength and endurance, and increased risk of rhabdomyolysis during refeeding [19]. Bone health is severely compromised, with osteopenia present in approximately 92% and osteoporosis in 40% of patients with anorexia nervosa [20]. The fracture risk is approximately seven times higher than in the general population, with trabecular bone loss particularly prominent and potentially irreversible even following weight restoration [21].

Connective tissue alterations emerge from reduced collagen synthesis and impaired tissue repair capacity. These changes increase injury susceptibility and contribute to characteristic postural abnormalities, including thoracic hyperkyphosis and forward head posture [22]. Functional exercise capacity is markedly reduced, with compromised $VO_2$max and diminished exercise tolerance directly correlating with nutritional status and cardiac adaptations [23,24].

The cognitive and psychological effects of malnutrition, documented extensively in the Minnesota Starvation Experiment, include impaired concentration, cognitive rigidity, preoccupation with food, depression, and anxiety [25]. These cognitive changes persist following initial refeeding, requiring extended nutritional rehabilitation for resolution and significantly impacting treatment engagement and therapeutic processes [26].

### *Excessive Exercise in Eating Disorders*

Excessive exercise in eating disorders extends beyond simple quantity or intensity considerations to encompass the quality, function, and psychological context of physical activity [27]. Definitions emphasize compulsivity, functional interference, and persistence despite adverse consequences. The functions of excessive exercise are multiple and interrelated: primary body weight and shape control, compensatory behavior following eating, emotional regulation, control-seeking in contexts of perceived helplessness, and body checking or reassurance-seeking [2,28].

The prognostic significance of excessive exercise is substantial. Patients engaging in excessive exercise demonstrate longer hospitalization duration, significantly lower remission rates, and more rapid relapse following treatment [3,29]. The behavior manifests both as formal structured exercise and as subtle micro-movements camouflaged within daily activities—walking rather than sitting, standing rather than resting, fidgeting, and maintaining muscle tension. These covert behaviors are particularly resistant to intervention and require vigilant monitoring and systematic addressing [30].

### *Evolution of Physical Activity Management in Eating Disorders*

Historical approaches to exercise management in eating disorders evolved through distinct phases. The abstinence era (1970s-1990s) prescribed complete bed rest with contingent reinforcement, wherein physical activity privileges were earned through weight gain. This approach frequently resulted in high relapse rates and deterioration of thera-

peutic alliance, as patients experienced the intervention as punitive and inconsistent with recovery goals [7].

Early reintegration approaches (2000-2015) recognized the potential therapeutic value of supervised exercise. Tokumura and colleagues demonstrated the feasibility of moderate exercise during weight gain in anorexia nervosa [31]. The LEAP (Loughborough Eating Disorders Activity Programme) provided structured psychoeducational modules addressing exercise motivations and developing healthier relationships with physical activity [32]. Exposure with response prevention protocols adapted from anxiety disorder treatment targeted compulsive exercise patterns through graduated exposure to exercise abstinence [33,34].

Contemporary guidelines (2017-2025) reflect consensus toward individualized, risk-stratified approaches. The Safe Exercise at Every Stage (SEES) framework provides differentiated guidance for adults (SEES-2), children and adolescents (SEES-Y), and athletes (SEES-A), emphasizing medical risk assessment, individualized prescription, and gradual progression [35,36,37]. The Royal College of Psychiatrists' MEED (Medical Emergencies in Eating Disorders) guidelines specify medical parameters for risk stratification [5]. The UK Physiotherapy guidance document provides comprehensive recommendations for physiotherapists working with individuals with eating disorders [12].

Despite these advances, integration of physical rehabilitation within a coherent psychological treatment framework remains limited, particularly in terms of systematic procedures for addressing the cognitive and emotional processes that occur during physical activity.

## The Villa Garda CBT-E Physical Rehabilitation Model

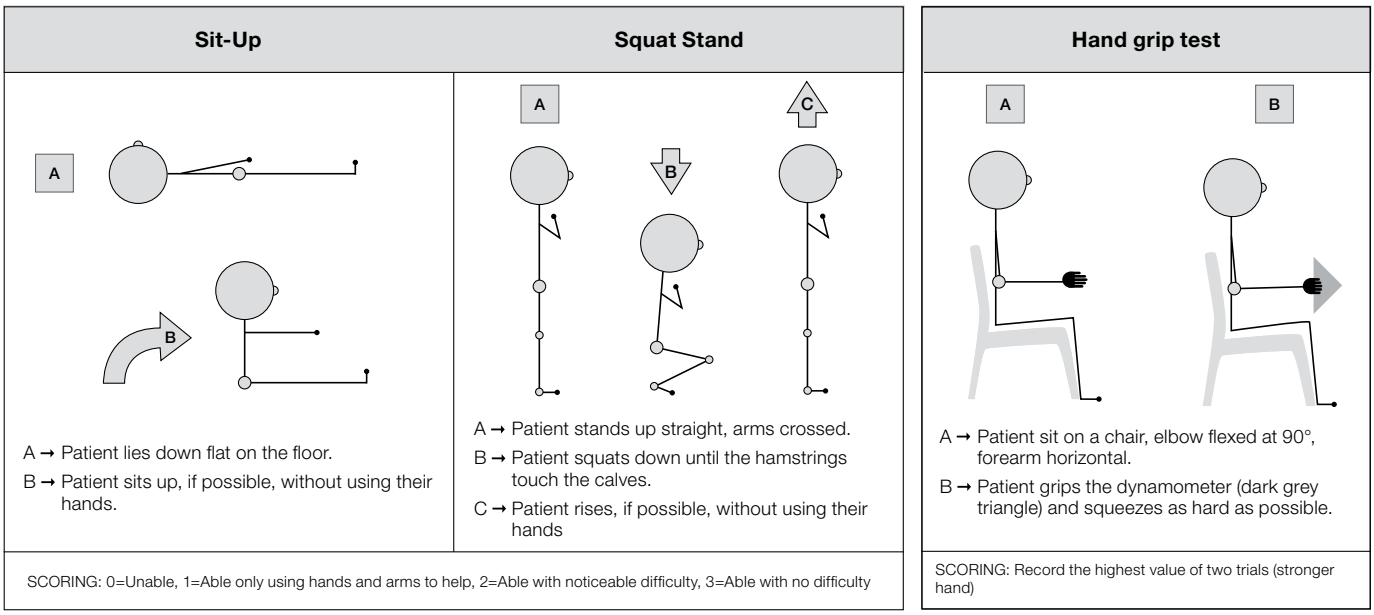
The physical rehabilitation model described here, developed at Villa Garda Hospital in Italy, integrates physical activity management within the CBT-E framework through a multi-phase approach that addresses both excessive exercise patterns and the progressive restoration of functional capacity. A distinguishing feature is the delivery of interventions by physiotherapists with extensive CBT-E training, enabling the systematic integration of psychological and physical rehabilitation strategies.

### *Assessment Protocols*

Comprehensive assessment precedes physical activity planning, incorporating both functional capacity evaluation and psychopathological assessment. The Sit-Up Squat-Stand (SUSS) and the Hand grip test (Figure 1) provides a standardized assessment of functional muscle strength [39]. In the Sit-Up Squat-Stand test patients perform specific movements (sit-up, squat, stand from chair) and are scored from 0 (unable) to 3 (normal ability), with intermediate scores indicating the need for hand assistance or difficulty.

Hand grip strength assessment provides an objective measurement of global muscle function, demonstrating excel-

**Figure 1.** Instructions for the Sit Up Squat Stand (SUSS) and Hand grip test



lent inter-rater reliability and strong correlation with nutritional status and medical risk [39,40]. Cut-off values derived from guidelines stratify risk: high risk (males <30.5kg, females <17.5kg), moderate risk (males <38kg, females <23kg), and low risk (males >38kg, females >23kg) [38].

Combined SUSS and handgrip strength assessment explains approximately 65% of the variance in BMI and BMI-based risk level, providing a robust foundation for risk stratification and activity planning [39].

### *Preliminary Phase: Managing Excessive Exercise*

Before initiating structured physical rehabilitation, systematic assessment and management of excessive exercise patterns are conducted within a CBT-structured framework. This phase is essential for patients presenting with active excessive exercise behaviors and requires differentiated approaches for formal structured exercise versus covert micro-movements embedded in daily activities.

The therapeutic approach follows a systematic progression. Initial sessions focus on developing awareness of egosyntonic strategies and the positive functions excessive exercise serves, recognizing that patients often perceive their exercise patterns as desirable rather than problematic. Therapists facilitate awareness of physical and psychosocial damage without confrontation, using open questioning and guided discovery to help patients recognize costs previously minimized or unacknowledged [41]. The exercise pattern is then integrated into the patient's personalized CBT-E formulation as a maintaining factor, explicitly linking it to core psychopathology and demonstrating how it perpetuates rather than resolves underlying concerns.

Collaborative evaluation of the advantages and disadvantages of modifying exercise patterns provides a foundation for shared goal-setting. This decisional balance work differs fundamentally from psychoeducation, actively engaging the patient's ambivalence and respecting autonomy [42]. Collaborative strategy development follows, with the patient and therapist jointly designing specific, individualized approaches to reduce excessive exercise. This may include real-time self-monitoring, identification of triggering situations, development of strategies to address the urges, such as alternative activities and urge tolerating, and graduated exposure to reduced exercise.

Implementation involves behavioral work between sessions, with patients actively practicing agreed-upon strategies and monitoring their experience. A crucial distinction is made between patients who genuinely attempt behavioral change but encounter difficulty ("I try but I can't") and those who do not attempt change ("I don't try"). The former represents a normal therapeutic process requiring strategy refinement and continued support; the latter indicates insufficient preparation and necessitates returning to earlier steps in the framework, particularly enhancing awareness of costs and strengthening the active patient's engagement.

For formal, structured excessive exercise, strategies include detailed real-time self-monitoring that captures context, cognitions, emotions, and consequences; identification of high-risk situations and triggers; development and rehearsal of alternative activities; and exposure with response prevention, gradually reducing exercise frequency, duration, or intensity while practicing tolerance of associated distress. For covert micro-movements, interventions require more intensive real-time monitoring due to their pervasive and often automatic nature, alongside the cultivation of moment-to-moment awareness, and the implementation of graduated behavioral experiments to practice alternative behaviors in specific situations.

Weekly review meetings with the treatment team and the patient (referred to as "round table" to emphasize their collaborative nature) provide a systematic review of excessive exercise management. These meetings ensure coordination between psychological and physical rehabilitation interventions and allow for rapid adjustment of strategies based on patient progress. This collaborative approach is essential, as excessive exercise management cannot occur in isolation from the broader treatment program.

### *Phase 1: Supervised Foundation*

Phase 1 initiates when patients achieve medical stability (typically BMI >15 kg/m$^2$) and demonstrate adequate control of excessive exercise patterns or commitment to managing them within the treatment framework. Physical activity occurs once weekly in supervised group sessions lasting 30 minutes, held in neutral environments without mirrors to minimize body-checking behaviors and body-comparison processes.

Exercise selection emphasizes functional movements with low performance emphasis, specifically chosen to facilitate psychological exploration rather than fitness development. The functional focus challenges patients' typical preoccupation with exercise outcomes (calories burned, muscle appearance, performance standards) by redirecting attention toward movement quality, bodily sensations, and internal experience.

Real-time monitoring of thoughts, emotions, impulses, and bodily sensations is a core intervention strategy, systematically implemented throughout sessions [43]. Patients learn to notice and verbalize their internal experience

during physical activity, developing metacognitive awareness of how exercise triggers or maintains eating disorder cognitions. This monitoring serves multiple functions: enhancing interoceptive awareness, identifying automatic thoughts and dysfunctional beliefs activated by exercise, and providing opportunities for cognitive restructuring in the moment.

Systematic verbal interventions target specific psychological mechanisms maintaining the eating disorder. These interventions, implemented throughout the session, address processes including rigid rule-following, perfectionism, body-checking and body-comparison behaviors, difficulty tolerating uncertainty, and emotional regulation deficits. A comprehensive taxonomy of verbal interventions (Table 1) maps each intervention type to targeted psychological mechanisms and underlying CBT-E rationale, ensuring theoretical coherence between physical and psychological treatment components.

The session structure incorporates specific elements designed to challenge maintaining processes. The warm-up deliberately provides vague instructions regarding duration and intensity, exposing patients' needs for precise rules and control while creating opportunities to practice flexibility and tolerance of ambiguity. The first exercise segment emphasizes open kinetic chain exercises (movements with free-moving distal segments), unilateral movements, and intentionally unbalanced durations between body sides (Table 2). These choices challenge compulsive counting, need for symmetry, and difficulty stopping activity, directly addressing maintaining mechanisms identified in the personal CBT-E formulation.

The second exercise segment introduces closed kinetic chain exercises (movements with fixed distal segments). It incorporates fatigue regulation challenges, requiring patients to adjust intensity based on subjective experience rather than predetermined rules. Exercise selection near session end based on patient preference provides practice in autonomous decision-making regarding physical activity, challenges external regulation, and promotes internalized, flexible activity engagement.

### *Phase 2: Enhanced Exposure*

Phase 2 adds a second weekly online group session, increasing total supervised activity to 2 sessions per week. Transition to Phase 2 occurs when patients demonstrate active engagement in addressing excessive exercise outside reha-

**Table 1.** Taxonomy of Systematic Verbal Interventions During Physical Activity Sessions

| Psychological Mechanism | Intervention Type | CBT-E Rationale | Example Application |
|---|---|---|---|
| Rigid rule-following | Flexible instruction provision | Challenge dichotomous thinking and need for precise rules | "Choose a duration that feels appropriate rather than counting exact repetitions" |
| Perfectionism | Performance de-emphasis | Reduce evaluation-based self-worth and outcome focus | "Focus on how the movement feels rather than how well you're performing it" |
| Body checking | Attention redirection | Interrupt checking behaviors and comparative processes | "Notice if you're looking at your body in the mirror or comparing yourself to others. Can you redirect attention to the sensations in your muscles?" |
| Difficulty tolerating uncertainty | Ambiguous instructions | Develop tolerance for unknown outcomes and uncontrolled situations | "We'll finish this exercise when the group seems ready rather than at a predetermined time" |
| External regulation | Choice provision | Develop autonomous decision-making and internal regulation | "Which exercise feels right for you now?" |
| Emotional regulation deficits | Emotion labeling | Enhance emotional awareness and develop alternative coping | "What emotions are you noticing as we do this exercise? Can you name them without judging them?" |
| Compulsive symmetry | Unbalanced durations | Challenge rigidity and need for perfect symmetry | "Let's do 30 seconds on the right side and 45 seconds on the left, noticing any urges to balance them" |

bilitation sessions, good compliance with Phase 1 requirements (particularly punctuality, regular attendance), and systematic use of the monitoring record during sessions. This phase introduces enhanced exposure across multiple dimensions.

Supervision decreases deliberately, requiring greater patient autonomy and self-regulation. Visual body exposure increases progressively because, beyond observing the trainer's body moving in the video, patients also see their own whole body in motion during the exercises—whether this takes place in a ward room rather than a dedicated gym space, or, for day-hospital patients, at home. These exposures directly target body image avoidance and checking behaviors, core maintaining mechanisms in eating disorders.

Language transitions from functional, neutral terminology to fitness- and body-focused language, providing graduated exposure to triggering exercise-related stimuli. Patients practice maintaining adaptive cognitive and emotional regulation while engaging with fitness culture messaging, preparing for real-world exercise environments saturated with appearance-focused content.

Patients develop skills in autonomous regulation of physical activity within increasingly stimulus-rich environments. The online format introduces additional challenges, including reduced immediate supervision, technology-mediated communication requiring greater verbal expression of internal states, and home environment triggers. This format prepares patients for continuing physical activity following discharge, when direct supervision will be unavailable.

### *Phase 3: Autonomous Integration*

Phase 3, offered to patients demonstrating adequate psychological engagement and self-regulation capacity, rigorous compliance with Phase 1 and 2 procedures, cessation of excessive exercise, and elimination of excessive exercise as a maintaining mechanism (with corresponding update of the personalized formulation), permits up to three weekly self-directed sessions in the hospital fitness center. This represents maximal exposure, placing patients in environments rich with eating disorder triggers: mirrors enabling continuous body checking, aesthetic-focused equipment and environments, a performance-oriented atmosphere, and cultural norms emphasizing appearance-based exercise motivations.

Patients select exercise type, intensity, and duration autonomously within shared health-focused guidelines, practicing self-directed physical activity. The physiotherapist remains present to supervise sessions and collaboratively help patients identify the most appropriate exercises. The emphasis shifts explicitly toward selecting exercises based on functional relevance and personal values rather than aesthetic goals. Patients identify movements and activities contributing to valued life activities—such as engaging in recreational sports and maintaining mobility for daily activities—rather than body modification.

When feasible, outdoor activities are incorporated, including team games, circuit training, dance, and online video-guided exercise. These activities introduce additional exposure elements: social comparison and observation by others, unpredictable and uncontrollable conditions, colla-

**Table 2.** Exercise Selection by Phase and Kinetic Chain Type

| Phase | Kinetic Chain | Body Region | Position | Exercise Examples | Therapeutic Rationale |
|---|---|---|---|---|---|
| 1 | Open | Upper body | Standing | Arm raises, lateral raises, punches | Challenge counting compulsions through unilateral work |
| 1 | Open | Lower body | Standing | Leg raises, hip abduction | Expose asymmetry tolerance through unbalanced durations |
| 1 | Closed | Lower body | Standing | Squats, lunges | Practice fatigue regulation and stopping ability |
| 1 | Closed | Upper body | Floor | Modified push-ups, planks | Challenge perfectionism through performance variability |
| 2 | Closed | Full body | Standing | Step-ups, wall sits | Develop autonomous intensity regulation |
| 2 | Open/Closed | Full body | Variable | Patient-selected exercises | Practice autonomous decision-making |
| 3 | Variable | Variable | Variable | Self-directed based on functional goals | Integration of all learned skills in autonomous context |

borative rather than competitive engagement, and joy-focused rather than outcome-focused experiences. The diversity of activities challenges the rigid, repetitive exercise patterns typical in eating disorders, promoting flexibility and experimentation.

Throughout Phase 3, patients continue real-time self-monitoring and apply cognitive behavior skills developed in earlier phases. The reduced supervision tests patients' capacity for independent management of exercise-related cognitions and emotions, providing essential practice for post-discharge maintenance. Patients demonstrating difficulty maintaining adaptive regulation return to Phase 2 for additional supported practice before attempting autonomous exercise again.

### *Integration with Individual CBT-E*

Physical rehabilitation integrates continuously with individual CBT-E sessions through multiple mechanisms. Exercise-related cognitions and behaviors identified during physical activity sessions become explicit agenda items during the weekly round table. Patients' personalized formulations incorporate exercise patterns and physical activity-related psychopathology as maintaining factors [44]. Behavioral tasks designed in individual psychological sessions may be implemented during physical activity sessions, providing ecologically valid contexts for testing predictions and developing alternative perspectives.

Weekly team meetings ensure coordination between physiotherapists and psychotherapists, enabling real-time adjustments to physical and psychological interventions based on patient progress and emerging needs. This collaborative structure is essential for maintaining theoretical coherence across treatment modalities and preventing contradictory messages or approaches.

## Discussion

The integration of physical rehabilitation within a CBT-E framework [10,11] aims to address a long-standing gap in eating disorder treatment: the systematic management of physical activity and restoration of functional capacity within an evidence-based psychological model. By training physiotherapists in CBT-E principles and embedding physical rehabilitation within individual formulation [44], the approach achieves theoretical coherence beyond the parallel delivery of separate interventions. Real-time cognitive and emotional monitoring during exercise [43] allows direct targeting of maintaining mechanisms, while graduated exposure to movement, bodily sensations, and loss of control parallels established exposure-based treatments [45] and promotes autonomous regulation.

A key strength of the model lies in its early and structured management of excessive exercise [2,27,28]. Rather than delaying physical rehabilitation until excessive exercise is fully resolved, supervised activity provides a health-oriented alternative to unsupervised exercise and a live context for skill acquisition and generalization. This CBT-structured approach [41,42] offers a potentially transferable framework for addressing excessive exercise, a behavior often insufficiently targeted in standard treatment.

Despite these conceptual strengths, the model remains preliminary. No empirical outcome data currently exist, and the described procedures reflect clinical practice rather than a validated intervention. Rigorous comparative effectiveness studies, including randomized controlled trials, are a priority to determine whether the integrated approach produces superior outcomes compared with non–CBT-E–based rehabilitation, guideline-driven risk management [5,35,36,37], or standard treatment. Evaluation should extend beyond weight and psychopathology to include physical functioning, body image, quality of life, treatment retention, and long-term regulation of physical activity.

Several methodological limitations warrant consideration. Functional assessment tools such as SUSS and hand grip strength testing [39,40] lack psychometric validation in eating disorder populations, particularly among adolescents, and sensitivity to treatment-related change remains unknown. The absence of validated adolescent-specific functional assessments represents a critical gap. Future research should focus on tool validation, optimization of clinical cut-offs, and development of age-specific norms, alongside investigation of objective biomarkers of physical adaptation to complement subjective measures.

Generalizability is another critical concern. The model has been implemented in a highly specialized inpatient setting with extensive resources, prolonged treatment duration, and highly trained staff. Adaptation to outpatient contexts, athletic populations [46], patients with significant comorbidities, and diverse cultural settings requires systematic development and evaluation. Mechanism-focused research is also needed to clarify the roles of interoceptive awareness [47], real-time cognitive monitoring [43], in-exercise verbal interventions, and graduated exposure [45] in driving change.

Several avenues may further enhance the model. The integration of structured psychoeducational modules [32], brief individual physiotherapy sessions, wearable activity monitoring, and a comprehensive fitness assessment [48],

interpreted within a CBT-E formulation [44], appears particularly promising. Preliminary clinical experience suggests that psychologically informed feedback on objective fitness data [23,24,48] may powerfully challenge distorted exercise beliefs and enhance motivation for change.

Overall, CBT-E–integrated physical rehabilitation represents a theoretically coherent and clinically promising approach. However, its clinical utility, scalability, and comparative effectiveness remain to be established through systematic empirical investigation.

## References

1. Calogero, R. M., & Pedrotty, K. N. (2004). The practice and process of healthy exercise: An investigation of the treatment of exercise abuse in women with eating disorders. *Eating Disorders*, 12(4), 273–291. doi: 10.1080/10640260490521352.
2. Dalle Grave, R., Calugi, S., & Marchesini, G. (2008). Compulsive exercise to control shape or weight in eating disorders: Prevalence, associated features, and treatment outcome. *Comprehensive Psychiatry*, 49(4), 346–352. doi: 10.1016/j.comppsych.2007.12.007.
3. Solenberger, S. E. (2001). Exercise and eating disorders: A 3-year inpatient hospital record analysis. *Eating Behaviors*, 2(2), 151–168. doi: 10.1016/S1471-0153(01)00026-5.
4. Shroff, H., Reba, L., Thornton, L. M., Tozzi, F., Klump, K. L., Berrettini, W. H., & Bulik, C. M. (2006). Features associated with excessive exercise in women with eating disorders. *International Journal of Eating Disorders*, 39(6), 454–461. doi: 10.1002/eat.20247.
5. Royal College of Psychiatrists. (2022). Medical emergencies in eating disorders (MEED): Guidance on recognition and management. College Report CR233.
6. Calugi, S., Miniati, M., Milanese, C., Sartirana, M., El Ghoch, M., & Dalle Grave, R. (2017). The Starvation Symptom Inventory: Development and psychometric properties. *Nutrients*, 9(9), 967. doi: 10.3390/nu9090967.
7. Thien, V., Thomas, A., Markin, D., & Birmingham, C. L. (2000). Pilot study of a graded exercise program for the treatment of anorexia nervosa. *International Journal of Eating Disorders*, 28(1), 101–106. doi: 10.1002/(SICI)1098-108X(200007)28:1<101::AID-EAT12>3.0.CO;2-V.
8. Dittmer, N., Jacobi, C., & Voderholzer, U. (2018). Compulsive exercise in eating disorders: Proposal for a definition and a clinical assessment. *Journal of Eating Disorders*, 6, 42. doi: 10.1186/s40337-018-0219-x.
9. Cook, B., Hausenblas, H., Tuccitto, D., & Giacobbi, P. R. (2011). Eating disorders and exercise: A structural equation modelling analysis of a conceptual model. *European Eating Disorders Review*, 19(3), 216–225. doi: 10.1002/erv.1111.
10. Fairburn, C. G. (2008). Cognitive Behavior Therapy and Eating Disorders. Guilford Press.
11. Dalle Grave, R., Calugi, S., Doll, H. A., & Fairburn, C. G. (2013). Enhanced cognitive behaviour therapy for adolescents with anorexia nervosa: An alternative to family therapy? Behaviour Research and Therapy, 51(1), R9–R12. doi: 10.1016/j.brat.2012.09.008.
12. Anderson, K., Reilly, M., Schaumberg, K., Anderson, L., & Gorrell, S. (2023). Physiotherapy in eating disorders guidance document (UK).
13. Misra, M., & Klibanski, A. (2014). Endocrine consequences of anorexia nervosa. *The Lancet Diabetes & Endocrinology*, 2(7), 581–592. doi: 10.1016/S2213-8587(13)70180-3.
14. Marra M, Sammarco R, De Filippo E, De Caprio C, Speranza E, Contaldo F, Pasanisi F. Resting Energy Expenditure, Body Composition and Phase Angle in Anorectic, Ballet Dancers and Constitutionally Lean Males. *Nutrients*. 2019 Feb 27;11(3):502. doi: 10.3390/nu11030502. PMID: 30818800; PMCID: PMC6471802.
15. Sachs, K. V., Harnke, B., Mehler, P. S., & Krantz, M. J. (2016). Cardiovascular complications of anorexia nervosa: A systematic review. *International Journal of Eating Disorders*, 49(3), 238–248. doi: 10.1002/eat.22481.
16. Schorr, M., & Miller, K. K. (2017). The endocrine manifestations of anorexia nervosa: Mechanisms and management. *Nature Reviews Endocrinology*, 13(3), 174–186. doi: 10.1038/nrendo.2016.175.
17. McLoughlin, D. M., Spargo, E., Wassif, W. S., Newham, D. J., Peters, T. J., Lantos, P. L., & Russell, G. F. M. (1998). Structural and functional changes in skeletal muscle in anorexia nervosa. *Acta Neuropathologica*, 95(6), 632–640. doi: 10.1007/s004010050850.
18. Rigaud, D., Moukaddem, M., Cohen, B., Malon, D., & Reveillard, V. (1997). Refeeding improves muscle performance without normalization of muscle mass and oxygen consumption in anorexia nervosa patients. *The American Journal of Clinical Nutrition*, 65(6), 1845–1851. doi: 10.1093/ajcn/65.6.1845.
19. Mehler, P. S., & Brown, C. (2015). Anorexia nervosa: Medical complications. *Journal of Eating Disorders*, 3, 11. doi: 10.1186/s40337-015-0040-8.
20. Rigotti, N. A., Nussbaum, S. R., Herzog, D. B., & Neer, R. M. (1984). Osteoporosis in women with anorexia nervosa. *New England Journal of Medicine*, 311(25), 1601–1606. doi: 10.1056/NEJM198412203112503.
21. Lucas, A. R., Melton, L. J., Crowson, C. S., & O'Fallon, W. M. (1999). Long-term fracture risk among women with anorexia nervosa: A population-based cohort study. *Mayo Clinic Proceedings*, 74(10), 972–977. doi: 10.4065/74.10.972.
22. Alberti, M., Galvani, C., El Ghoch, M., Capelli, C., Lanza, M., Calugi, S., & Dalle Grave, R. (2013). Assessment of physical activity in anorexia nervosa and treatment outcome. *Medicine & Science in Sports & Exercise*, 45(9), 1643–1648. doi: 10.1249/MSS.0b013e31828e8f07.
23. Alberti M, Galvani C, Capelli C, Lanza M, El Ghoch M, Calugi S, Dalle Grave R. Physical fitness before and after weight restoration in anorexia nervosa. *J Sports Med Phys Fitness*. 2013 Aug;53(4):396-402. PMID: 23828287.
24. El Ghoch, M., Calugi, S., Pellegrini, M., Milanese, C., Busacchi, M., Battistini, N. C., … Dalle Grave, R. (2013). Measured physical activity in anorexia nervosa: Features and treatment outcome. *International Journal of Eating Disorders*, 46(7), 709–712. doi: 10.1002/eat.22140.

25. Keys, A., Brozek, J., Henschel, A., Mickelsen, O., & Taylor, H. L. (1950). The Biology of Human Starvation. University of Minnesota Press.
26. Dalle Grave, R., Di Pauli, D., Sartirana, M., Calugi, S., & Shafran, R. (2007). The interpretation of symptoms of starvation/severe dietary restraint in eating disorder patients. *Eating and Weight Disorders*, 12(3), 108–113. doi: 10.1007/BF03327637.
27. Meyer, C., Taranis, L., Goodwin, H., & Haycraft, E. (2011). Compulsive exercise and eating disorders. *European Eating Disorders Review*, 19(3), 174–189. doi: 10.1002/erv.1122.
28. Dalle Grave, R. (2009). Features and management of compulsive exercising in eating disorders. *The Physician and Sportsmedicine*, 37(3), 20–28. doi: 10.3810/psm.2009.10.1725.
29. Strober, M., Freeman, R., & Morrell, W. (1997). The long-term course of severe anorexia nervosa in adolescents: Survival analysis of recovery, relapse, and outcome predictors over 10–15 years in a prospective study. *International Journal of Eating Disorders*, 22(4), 339–360. doi: 10.1002/(SICI)1098-108X(199712)22:4<339::AID-EAT1>3.0.CO;2-N
30. Goodwin, H., Haycraft, E., Taranis, L., & Meyer, C. (2011). Psychometric evaluation of the Compulsive Exercise Test (CET) in an adolescent population: Links with eating psychopathology. *European Eating Disorders Review*, 19(3), 269–279. doi: 10.1002/erv.1109.
31. Tokumura, M., Yoshiba, S., Tanaka, T., Nanri, S., & Watanabe, H. (2003). Prescribed exercise training improves exercise capacity of convalescent children and adolescents with anorexia nervosa. *European Journal of Pediatrics*, 162(6), 430–431. doi: 10.1007/s00431-003-1203-1.
32. Hay P, Touyz S, Arcelus J, Pike K, Attia E, Crosby RD, Madden S, Wales J, La Puma M, Heriseanu AI, Young S, Meyer C. A randomized controlled trial of the compuLsive Exercise Activity TheraPy (LEAP): A new approach to compulsive exercise in anorexia nervosa. *Int J Eat Disord*. 2018 Aug;51(8):999-1004. doi: 10.1002/eat.22920. Epub 2018 Jul 26. PMID: 30051623.
33. Dittmer, N., Voderholzer, U., von der Mühlen, M., Marschner, N., Mönninghoff, C., & Schlegl, S. (2020). Efficacy of a Specialized Group Intervention for Compulsive Exercise in Inpatients with Anorexia Nervosa: *A Randomized Controlled Trial. Psychotherapy and Psychosomatics*, 89(3), 161–173. doi: 10.1159/000504583.
34. Ng, L. W. C., Ng, D. P., & Wong, W. P. (2013). Is supervised exercise training safe in patients with anorexia nervosa? A meta-analysis. *Physiotherapy*, 99(1), 1–11. doi: 10.1016/j.physio.2012.05.006.
35. Cook, B. J., & Wonderlich, S. A. (2024). Safe Exercise at Every Stage (SEES-2): Guide for adults.
36. Cook, B. J., & Long, C. (2024). Safe Exercise at Every Stage (SEES-Y): Guide for children and adolescents.
37. Cook, B. J., & Engel, S. (2024). Safe Exercise at Every Stage (SEES-A): Guide for athletes.
38. Robinson, P., & Rhys Jones, W. (2018). MARSIPAN: Management of really sick patients with anorexia nervosa. *BJPsych Advances*, 24(1), 20–32. doi: 10.1192/bja.2017.2.
39. Etemadi, S., Sun, G. X., Leung, S. P., et al. (2021). The Sit Up Squat Stand test and Hand Grip Strength: What is the role of tests of muscle power in risk assessment in anorexia nervosa? *European Eating Disorders Review*, 29(4), 670–679. doi: 10.1002/erv.2839.
40. Norman, K., Stobäus, N., Gonzalez, M. C., Schulzke, J.-D., & Pirlich, M. (2011). Hand grip strength: Outcome predictor and marker of nutritional status. *Clinical Nutrition*, 30(2), 135–142. doi: 10.1016/j.clnu.2010.09.010.
41. Cooper, Z., & Dalle Grave, R. (2017). Eating disorders: Transdiagnostic theory and treatment. In *The Science of Cognitive Behavioral Therapy* (pp. 337–357). Academic Press. doi: 10.1016/B978-0-12-803457-6.00014-3.
42. Miller, W. R., & Rollnick, S. (2012). *Motivational Interviewing: Helping People Change* (3rd ed.). Guilford Press.
43. Fairburn, C. G., Cooper, Z., & Shafran, R. (2003). Cognitive behaviour therapy for eating disorders: A "transdiagnostic" theory and treatment. *Behaviour Research and Therapy*, 41(5), 509–528. doi: 10.1016/S0005-7967(02)00088-8.
44. Dalle Grave, R. (2013). Multistep Cognitive Behavioral Therapy for Eating Disorders: Theory, Practice, and Clinical Cases. Jason Aronson.
45. Foa, E. B., Huppert, J. D., & Cahill, S. P. (2006). Emotional processing theory: An update. In B. O. Rothbaum (Ed.), Pathological Anxiety: Emotional Processing in Etiology and Treatment (pp. 3–24). Guilford Press. ISBN: 1-59385-223-1
46. Bratland-Sanda, S., & Sundgot-Borgen, J. (2013). Eating disorders in athletes: Overview of prevalence, risk factors and recommendations for prevention and treatment. *European Journal of Sport Science*, 13(5), 499–508. doi: 10.1080/17461391.2012.740504.
47. Khalsa, S. S., Adolphs, R., Cameron, O. G., et al. (2018). Interoception and Mental Health: A Roadmap. Biological Psychiatry: *Cognitive Neuroscience and Neuroimaging*, 3(6), 501–513. doi: 10.1016/j.bpsc.2017.12.004.
48. Council of Europe Committee for the Development of Sport. (1993). EUROFIT: Handbook for the EUROFIT Tests of Physical Fitness (2nd ed.). Council of Europe Publishing and Documentation Service.

## Appendix: Exercise Descriptions

The following descriptions detail the execution of exercises referenced in Table 2. Exercises are organized by kinetic chain type (open vs. closed), body region, and position.

### *Open Kinetic Chain Exercises - Lower Limbs*

#### *Supine Single-Leg Hip Flexions*

**Execution:** The patient lies supine with one leg flexed (foot on the floor) and the other leg extended with knee straight and foot in dorsiflexion. The exercise consists of repeatedly flexing and extending the hip of the extended leg to approximately 90° of flexion, maintaining pelvic stability and a regular rhythm. Execute with one limb at a time (first right, then left).

***Seated Single-Leg Hip-Knee Extension Combo***

**Execution:** The patient sits on the edge of a chair with upright trunk and without leaning against the backrest, feet on the floor. Lift one knee toward the chest (hip flexion) as far as comfortable while maintaining stable pelvis; from this position, extend the knee of the same limb, bringing the leg forward with foot in dorsiflexion and holding the position for 3-5 seconds. Then flex the knee again (returning the thigh toward the chest) and return the foot to the floor. The trunk remains still with active core engagement. Execute all repetitions with one leg (right) then with the other (left).

***Standing Single-Leg Hip Abductions***

**Execution:** The patient stands with one hand supported on a wall or chair back for balance. Maintains weight on the support foot and raises the other leg laterally with knee extended and foot relaxed, without tilting the trunk. Returns to neutral position and repeats. Work one limb at a time (series on the right leg, then on the left).

### *Open Kinetic Chain Exercises - Upper Limbs*

***Supine Single-Arm Shoulder Flexions***

**Execution:** The patient lies supine with both arms along the sides. Slowly raises one arm in flexion overhead as far as comfortable, maintaining the elbow extended, then returns the arm along the side. The trunk remains relaxed and stable. Execute multiple repetitions with the same limb then switch to the other.

***Seated Single-Arm Shoulder Abductions***

**Execution:** The patient sits with upright trunk and arms along the sides. Raises one arm laterally (abduction) to shoulder height or slightly beyond, maintaining the elbow slightly flexed and shoulder relaxed, then returns. Work one limb at a time, maintaining control of movement and respiratory rhythm.

***Standing Single-Arm Reverse Flys with Forward Trunk Lean***

**Execution:** The patient stands with feet hip-width apart, trunk flexed forward with neutral spine and active core. From this position, raises one arm outward and slightly backward with elbow slightly flexed to shoulder height, bringing the scapula toward the spine; holds for 1-2 seconds, then slowly lowers the arm without rotating the torso. Executes all repetitions with one limb then with the other. To increase difficulty, can slow the lifting phase and isometric hold.

### *Open Kinetic Chain Exercises - Trunk Muscles*

***Supine Dead Bug***

**Execution:** The patient lies supine with hips and knees flexed to 90°, arms extended upward. From this position, slowly extends one leg toward the floor and simultaneously brings the contralateral arm overhead, maintaining the lumbar spine adherent to the floor; then returns to center and alternates sides. The movement is alternated and controlled, with global engagement of trunk and limbs.

***Seated Trunk Rotations with Opposite Knee-Elbow Touch***

**Execution:** The patient sits with upright trunk and feet on the floor. Places hands behind the head or crossed on the chest and, maintaining stable pelvis, flexes and rotates the trunk to bring the elbow toward a knee, which lifts slightly toward the torso; then returns and repeats toward the opposite side. Alternate sides with regular rhythm.

***Standing Marching with Opposite Hand-Knee Touch***

**Execution:** The patient stands with feet hip-width apart. Executes marching in place by alternately raising the knees; with each step, brings the opposite hand to touch the rising knee, maintaining upright and stable trunk. The movement is rhythmic and coordinated, with engagement of lower limbs, upper limbs, and core control.

### *Closed Kinetic Chain Exercises - Lower Limbs*

***Supine Bilateral Glute Bridge***

**Execution:** The patient lies supine with knees flexed and feet on the floor, hip-width apart. From this position, lifts the pelvis toward the ceiling, creating a straight line from knees to shoulders, holds for 3-5 seconds, then slowly lowers the pelvis. The movement is controlled, with attention to posterior pelvic tilt and glute activation.

***Seated Single-Leg Foot Slides***

**Execution:** The patient sits on the edge of a chair with upright trunk and both feet on the floor. Slowly slides one foot forward, extending the knee as far as comfortable while maintaining the heel in contact with the floor and stable trunk; holds for 3-5 seconds in maximum extension, then slowly returns without losing foot-floor contact. To increase difficulty, can slightly lift the other foot in the final repetitions. Then repeat with the contralateral limb.

***Standing Single-Leg Knee Extensions***

***Execution:*** The patient stands with hands supported on a stable surface for balance. Lifts one leg so the thigh is approximately horizontal, then extends the knee, bringing the lower leg forward with foot in dorsiflexion; holds briefly and returns to the starting position without tilting. The other leg remains extended with active glutes and core. Execute multiple repetitions with one leg at a time (first a series with the right, then with the left).

### *Closed Kinetic Chain Exercises - Upper Limbs*

#### *Prone Push-Ups with Knee Support*

***Execution:*** The patient lies prone with hands on the floor under the shoulders and knees on the floor. From this position, extends the elbows pushing the body upward as a block (from knees to shoulders), then flexes the elbows returning in a controlled manner toward the floor. The load is shared by both upper limbs. Adjust the range of motion based on strength and any pain.

#### *Seated Arm Press-Ups (Pelvis Lifts)*

***Execution:*** The patient sits on a stable chair with hands on the seat edges next to the hips. Maintaining feet on the floor, extends the elbows pushing down with the hands to slightly lift the pelvis from the seat, holding for 1-2 seconds, then slowly returns to the starting position. The trunk remains stable; the exercise is executed symmetrically with both upper limbs.

#### *Standing Wall Push-Ups*

***Execution:*** The patient stands facing a wall with feet slightly back and hands on the wall at chest height. Flexes the elbows bringing the body toward the wall while maintaining the body aligned, then extends the elbows pushing away from the wall. Symmetrical work of both upper limbs with control of movement and scapula.

### *Closed Kinetic Chain Exercises - Trunk Muscles*

#### *Side Plank on Forearm and Knees*

***Execution:*** The patient lies on their side with support on the lower forearm and flexed knees. From this position, lifts the pelvis from the floor creating a straight line between knees, hips, and shoulders, holds for several seconds, and slowly returns. Executes a series on one side then repeats on the opposite side. Global work on trunk, shoulder girdle, and pelvic girdle in closed chain.

#### *Seated Weight Transfers*

***Execution:*** The patient sits on a chair with feet well supported on the floor and hands on the seat edges or armrests. Pushes simultaneously with feet and hands against their respective supports to partially lift the pelvis and lighten the load from the chair, maintaining aligned trunk, then slowly returns to sitting. Global exercise with engagement of upper limbs, lower limbs, and core.

#### *Bodyweight Squats with Arms Forward*

***Execution:*** The patient stands with feet shoulder-width apart and arms extended forward. Simultaneously flexes hips and knees, bringing the pelvis back as if to sit, maintaining weight distributed on the feet, knees aligned with feet, and trunk slightly inclined but aligned; then extends hips and knees to return to standing. Global closed-chain movement engaging lower limbs and trunk control.