

The Application of Traditional Chinese Health-Preserving Exercises in Postoperative Rehabilitation After Cardiovascular Surgery: Theoretical Logic, Mechanisms of Action, and Research Agenda

Jieyu Cao, Jia Liu, Xiangyang Hu, Zhengwen Lei*

Department of Cardiothoracic and Vascular Surgery, The First Affiliated Hospital of Hengyang Medical School, University of South China, Hengyang 421001, Hunan, China

*Corresponding author: Zhengwen Lei, leizhengwen0803@163.com

Copyright: © 2026 Author(s). This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), permitting distribution and reproduction in any medium, provided the original work is cited.

Abstract: Postoperative rehabilitation after cardiovascular surgery faces multiple barriers, including decline in physiological function, kinesiophobia, and low exercise adherence. Among the traditional Chinese health-preserving exercises—such as Tai Chi, Baduanjin, Wuqinxi, and Liuzijue—there is an established triad of features labeled “body regulation–breath regulation–mind regulation,” which seems to offer special benefits for cardiovascular rehabilitation. The present article gives a coherent account of both the theory and the practical mechanisms of such exercises as they pertain to postoperative care of the cardiovascular system. From a physiological standpoint, Tai Chi can greatly lower systolic blood pressure (SBP) and diastolic blood pressure (DBP), and Baduanjin is of value for left ventricular ejection fraction (LVEF) and 6-minute walk distance (6MWD). In terms of neural function, traditional Chinese health-preserving exercises seem to help remodel the brain—by means of increased functional coupling of the prefrontal cortex–amygdala complex or of the default mode network (DMN). With regard to psychological aspects, their mindful attention component may help to achieve fear extinction and relieve kinesiophobia. The prevalence of postoperative kinesiophobia following cardiovascular surgery is as high as 39.20%–82.57%, making it a basic bottleneck for rehabilitation. With this in mind, this article proposes a theoretical pathway of “brain functional remodeling as a factor in kinesiophobia → better long-term prognosis (in general)” and recommends advancing progress along four lines—specifically, theoretical model construction, multimodal neuroimaging mechanism validation, well-organized randomized controlled trials (RCTs), and guideline translation—this being a theoretical justification for the kind of standardized treatment—using traditional Chinese health-preserving exercises—for postoperative rehabilitation following cardiovascular surgery.

Keywords: Traditional Chinese forms of health-promoting exercise; Cardiovascular surgery; Rehabilitation after operation; Kinesiophobia; Functional remodeling of the brain; Theoretical mechanisms

Online publication: September 30, 2026

1. Introduction

Cardiovascular disease is by far the main source of death and of disability throughout the world—hence a major burden for health services. In recent years—given developments in surgery—the success rate of cardiovascular surgery is now much better than it used to be; still, surgical success is not an end but rather a beginning of treatment, and the quality of postoperative rehabilitation is directly related to the long-term prognosis and quality of life ^[1]. However, after cardiovascular surgery, rehabilitation presents many problems—among them, a frequent drop in cardiopulmonary performance ^[2], a decrease in capacity for exercise endurance ^[3], certain psychological conditions—specifically anxiety or depression ^[4]- as well as behavioral conditions—among them kinesiophobia ^[5]. Studies have shown that the prevalence of kinesiophobia following cardiac surgery is as high as 39.20%–82.57% ^[6]. Kinesiophobia is not merely a direct limitation lowering one’s confidence in exercise and bringing on anxiety or depression; in the long run, it is associated with progressive loss of cardiopulmonary capacity and with higher chances of serious cardiovascular events (MACE). If one is confronted with such difficulties, it is true that standard cardiac rehabilitation regimens lower both mortality and the risk of hospital admission ^[7], yet their use in China is not widespread. Certain obstacles—regional disparities in care, fragmented referral pathways, and patients’ psychological concerns about exercise—restrict the promotion of cardiac rehabilitation ^[8]. A number of scholars have noted that cultural expectations of Chinese patients favor pharmacological treatment over exercise management, further exacerbating the difficulty of cardiac rehabilitation participation ^[7]. With that in mind, it is worth identifying—among possible solutions—a safe, efficient, widely available, and culturally congruent rehabilitation approach, which is of great clinical and social importance.

Traditional Chinese health-preserving exercises—Tai Chi, Baduanjin, Wuqinxi, Liuzijue, etc.—are characterized by the integrated triad of “body regulation–breath regulation–mind regulation” and possess the dual functions of physical activity and mind-body regulation. In recent years, the application of these traditional exercises in cardiovascular rehabilitation has attracted increasing attention. A systematic review and meta-analysis including 60 studies (39 randomized controlled trials [RCTs]) showed that Tai Chi can significantly reduce systolic blood pressure (SBP) (mean difference [MD] –6.14 mmHg, 95% confidence interval [CI] –8.44 to –3.84) and diastolic blood pressure (DBP) (MD –3.45 mmHg, 95% CI –4.50 to –2.40) ^[9]. A network meta-analysis including 48 RCTs (4,184 patients) indicated that Baduanjin was most effective in reducing heart rate (standardized mean difference [SMD] = –1.60) and improving vascular endothelial function ^[10]. However, research on the application of traditional Chinese health-preserving exercises in postoperative rehabilitation after cardiovascular surgery is almost absent, and their theoretical logic and mechanisms of action urgently need to be systematically elucidated.

This article aims to elaborate systematically, at the theoretical level, the application logic and mechanisms of action of traditional Chinese health-preserving exercises in postoperative rehabilitation after cardiovascular surgery, explore their unique value distinguishing them from ordinary aerobic exercise, and propose a future research agenda, with the aim of providing a theoretical framework for clinical research and practice in this field (Figure 1).



Figure 1. Traditional qigong in postoperative rehabilitation after cardiac surgery. SBP, systolic blood pressure; DBP, diastolic blood pressure; LVEF, left ventricular ejection fraction; 6MWD, 6-minute walk distance; DMN, default mode network; MACE, major adverse cardiovascular events; RCT, randomized controlled trial.

2. Traditional Chinese health-preserving exercises: Concepts and classification

2.1. Main exercises and their characteristics

Traditional Chinese health-preserving exercises have a long history and have developed into multiple exercise systems represented by Tai Chi, Baduanjin, Wuqinxi, Liuzijue, etc. Tai Chi centers on slow, continuous, and circular limb movements, with an emphasis on “directing qi with the mind and mobilizing the body with qi”; Tai Chi is based upon slow, unbroken, circular limb motion; it has a moderate level of exercise and little joint loading, making it suitable for people of all ages. Baduanjin has eight sections—each one designed to help a particular viscera or part of the body—yet they are not difficult to perform and have clear effects of strengthening the body. Wuqinxi is an imitation—more or less—of the movements of five animals—tiger, deer, bear, monkey, and bird—along with their limb stretching and breath coordination. In Liuzijue one finds six exhalation techniques—“xu, he, hu, si, chui, xi”—with an eye to the relation of breath regulation and bodily functions.

2.2. The core characteristic of the integrated triad of “body regulation–breath regulation–mind regulation”

The main trait which sets off traditional Chinese health-preserving exercises from ordinary aerobic exercise is their mind-body model of the combined triad of “body regulation–breath regulation–mind regulation.” “Body regulation” refers to slow, continuous, rhythmic motions of the body—above all, accuracy and coordination of movements. “Breath regulation” stands for deep, long, okay—abdominal breathing is fine, and it affects the autonomic nervous system’s function via control of the respiratory rhythm; “mind regulation” describes a form of attention—physical and mental—that is centered and undistracted relaxation—something with a built-in element of meditation. Here are the three; each one of them helps the others—thus forming the

singular mind-body model of traditional Chinese health-preserving exercises as an intervention. Some published studies now claim that traditional Chinese health-preserving exercises—by virtue of their integrative effects on body and mind—can lead to a variety of beneficial results (physiological, mental, or neural) at many levels ^[11].

2.3. Similarities and differences from common forms of aerobic activity and of mindfulness meditation

The central difference between traditional Chinese health-preserving exercises and ordinary aerobic exercise lies in their mind-body synergy. Common aerobic activities, such as brisk walking and swimming, are mainly aimed at improving cardiopulmonary endurance through exercise intensity, duration, and frequency. Traditional Chinese exercises, by contrast, help maintain health. In moderate-intensity aerobic exercise, they are characterized by breath regulation and focused attention; these two together form a special “exercise + meditation” composite model. One controlled study looked at brain functional connectivity—among Tai Chi users and among people who do aquatic aerobic exercises—and concluded that the Tai Chi group had unique functional connectivity in both resting state and cognitive tasks—particularly enhanced connectivity of the anterior cingulate cortex and insula—areas that are strongly linked with interoceptive awareness, with regard to cognitive control, or to motor organization ^[12]. This finding suggests that the mechanisms by which traditional Chinese health-preserving exercises affect brain function may differ from those of ordinary aerobic exercise.

Compared with mindfulness meditation, traditional Chinese health-preserving exercises, while maintaining mindful attention, add the dimension of physical movement, giving rise to a unique model of “cultivating stillness within movement.” Mindfulness meditation primarily promotes fear extinction and emotion regulation through enhanced functional connectivity of the prefrontal cortex–amygdala pathway ^[13]; traditional Chinese health-preserving exercises, however, may produce more comprehensive neuromodulatory effects through the synergy of movement, breath, and mindfulness.

3. Needs and problems of postoperative rehabilitation: An analysis of cardiovascular surgery

3.1. Physiological level: Diminished cardiopulmonary function and reduced exercise endurance

Although cardiovascular surgery can correct certain structural defects of the heart and its major vessels, most patients face difficulties in cardiopulmonary performance and exercise endurance after surgery. With regard to acute Stanford type A aortic dissection (AD), for instance, even with a fully successful operation, patients’ exercise capacity remains greatly reduced. Patients after AD surgery face a unique rehabilitation dilemma: on the one hand, exercise training can lower heart rate, blood pressure, and body weight and improve cardiovascular health; on the other hand, exercise-related abrupt increases in blood pressure may increase the risk of recurrent aortic events. This contradiction of “exercise is beneficial but risks coexist” often makes clinicians hesitant when prescribing exercise. Studies have shown that 71% of patients after AD surgery hope to receive clear guidance on exercise safety, but current guidelines lack specific threshold parameters for blood pressure or heart rate ^[14].

3.2. Psychological level: Kinesiophobia, anxiety and depression, and post-traumatic stress

Kinesiophobia is one of the core psychological barriers in postoperative rehabilitation after cardiovascular surgery. Kinesiophobia refers to an excessive, irrational fear of physical activity arising from the concern that activity may lead to re-injury or adverse consequences. In patients after cardiovascular surgery, this fear is particularly prominent—patients have experienced life-threatening acute events and traumatic surgery, and after surgery they are often told to “avoid strenuous exercise” and “control blood pressure,” yet lack clear guidance on “what exercise is safe and what intensity is appropriate,” leading many patients to remain afraid to move even after obtaining medical clearance.

A scoping review showed that influencing factors of kinesiophobia after cardiac surgery include demographic characteristics, pain severity, frailty, exercise self-efficacy, disease-related factors, and psychosocial factors ^[15]. Kinesiophobia leads to adverse health outcomes such as delayed recovery, prolonged hospital stay and reduced quality of life, but intervention studies targeting postoperative kinesiophobia are extremely limited. Intervention studies based on the fear-avoidance model have initially shown that graded activity, functional feedback, goal setting, and structured education can significantly improve patients’ perceived physical ability and thereby indirectly reduce kinesiophobia levels ^[16]. It seems likely that traditional Chinese health-preserving exercises—being of low intensity, safe, and easily controlled—may alleviate kinesiophobia through similar mechanisms.

3.3. Behavioral level: Low degree of exercise adherence and low cardiac rehabilitation involvement

Exercise adherence is a key factor affecting the effectiveness of cardiac rehabilitation.

Studies have shown that exercise self-efficacy, as a core psychological mechanism of cardiac rehabilitation, not only predicts exercise behavior but also maintains exercise motivation; however, most patients have low levels of exercise self-efficacy ^[17]. A direct negative relationship exists between kinesiophobia and exercise self-efficacy—more intense kinesiophobia means a lower likelihood of regular exercise by the patient. For China as a whole, low cardiac rehabilitation participation is a serious issue. A number of systematic reviews now indicate that Chinese cardiac rehabilitation runs into many difficulties, namely, a regional imbalance in available medical resources, fragmented referral pathways, and a serious shortage of rehabilitation facilities. Cultural factors also play a role—many patients tend to prefer pharmacological treatment over exercise management ^[18]. Therefore, choosing an exercise rehabilitation approach that aligns with patients’ cultural identity and is highly accessible is of great significance for improving cardiac rehabilitation participation.

3.4. Social level: Lack of standardized protocols and uneven distribution of medical resources

Postoperative rehabilitation after cardiovascular surgery lacks targeted standardized protocols. Systematic reviews indicate that high-quality evidence in the field of cardiac rehabilitation after AD surgery is severely lacking, and existing studies are mostly observational ^[14,19]. Although the 2022 American Heart Association/American College of Cardiology (AHA/ACC) guidelines recommend cardiac rehabilitation after AD surgery, the supporting evidence is extremely limited ^[20]. A recent multicenter RCT preliminarily confirmed the safety and feasibility of moderate-intensity home-based exercise in AD survivors, but the sample size was small and long-term follow-up was lacking ^[21].

4. Mechanisms of action of Traditional Chinese health-preserving exercises

4.1. Physiological mechanisms: Hemodynamics, cardiac function, autonomic nervous system, and inflammation

The protective effects of traditional Chinese health-preserving exercises on the cardiovascular system have now been verified in many populations having cardiovascular disease. A systematic review and meta-analysis provide strong evidence that Tai Chi reduces SBP (MD -6.14 mmHg) and DBP (MD -3.45 mmHg), as well as resting heart rate (SMD = -0.57), which is an indication of better autonomic nervous function^[9]. With regard to vascular endothelial function, Baduanjin can significantly increase nitric oxide (NO) levels (SMD = 0.96) and reduce endothelin-1 (ET-1) concentrations (SMD = -0.91). As far as cardiac function is concerned, a systematic review of 13 RCTs (involving 1,293 patients) gives the result that Baduanjin is of major value in improving LVEF (MD = 6.20% , 95% CI $3.14-9.25$) as well as 6MWD (MD = 60.21 m, 95% CI $17.96-102.46$) for patients who have undergone percutaneous coronary intervention (PCI)^[22]. The practice of Baduanjin also resulted in a very substantial reduction in anxiety and depressive symptoms—Hamilton Anxiety Scale (HAMA) scores showed a mean decrease of 1.40 points, and Hamilton Depression Scale (HAMD) scores showed a mean decrease of 2.80 points^[23]. These findings indicate that traditional Chinese health-preserving exercises, while improving cardiovascular function, also exert significant psychological regulatory effects. As far as inflammatory regulation is concerned, traditional Chinese health-preserving exercises may act through autonomic nervous regulation and inflammation/stress-related pathways.

4.2. Psychological aspects: Self-efficacy, fear extinction—along with emotion regulation

Conventional Chinese practices for preserving one's health deal at once with the mental, the emotional, and the behavioral sides of kinesiphobia with regard to the three-dimensional interaction called “body regulation–breath regulation–mind regulation.” At the cognitive level, the “body regulation” component helps patients rebuild the cognitive association of “exercise = safety” through slow, manageable, and safe movement experiences. A persistent reinforcement of these safe exercise experiences seems helpful in reversing the conditioned fear linked to “exercise = danger.” From an emotional standpoint, the “breath regulation” and “mind regulation” components encourage the body's own desensitization to fear responses by activating the parasympathetic nervous system and lowering sympathetic nervous tension. As far as behavior is concerned, the three-dimensional synergistic effect promotes not only confidence but also persistence in exercising—by means of better self-efficacy.

A nursing intervention study based on the fear-avoidance model provides indirect support for the above mechanisms. The research now shows that an intervention based on graded activity, functional feedback, goal setting, and structured education significantly reduces levels of kinesiphobia by improving patients' perceived physical ability (indirect effect $ab = -1.879$, 95% CI -3.702 to -0.288)^[24]. The “body regulation” component of traditional Chinese health-preserving exercises is highly consistent with the concept of graded activity—helping patients gradually build confidence in exercise through low-intensity, progressive movement experiences.

4.3. Neural mechanisms: Prefrontal cortex–amygdala pathway, DMN, and central autonomic network (CAN)

The regulatory effects of traditional Chinese health-preserving exercises involving the brain—i.e., mental exercises—now draw growing attention in neuroscience research. A systematic review and a meta-analysis

provide strong evidence that mind-body exercise has major impacts—on brain activation, on functional neural connections, and on structure^[25]. As far as functional brain connectivity is concerned, Tai Chi practitioners show improved functional connectivity between the anterior cingulate cortex and the insula—areas connected to interoception, to cognitive control, and to motor patterns. One study reports that Tai Chi is capable of improving the functional coupling of the amygdala with the medial prefrontal cortex, supporting therapeutic strategies that promote emotion regulation—specifically, reinforcement of the prefrontal cortex–amygdala connection^[26].

The core neural circuits for the expression of fear memories involve the prefrontal cortex–amygdala pathway—here, the ventromedial prefrontal cortex regulates the expression of fear memories by actively inhibiting the amygdala, and its activation or thickness is important for successful fear memory extinction. It is now known that mindfulness meditation helps to improve ventromedial prefrontal cortex–amygdala structural or functional connectivity—this seems to encourage fear extinction learning. The “mind regulation” part of the traditional Chinese health-preserving exercises—centered attention and physical and mental relaxation—has, by its very nature, certain similarities with mindfulness meditation and is possibly helpful in bringing about the extinction of kinesiphobia via similar mechanisms. On a larger network scale, the CAN functions as a regulatory hub—linking the prefrontal cortex, insula, anterior cingulate cortex, and amygdala—and brings about integration of autonomic nervous activity by means of top-down regulation and bottom-up physiological feedback. With regard to dynamic causal modeling, it has been shown that effective connectivity from the amygdala to the anterior cingulate cortex and ventrolateral prefrontal cortex is linked negatively to heart rate variability and positively connected to heart rate—this indicates that the prefrontal cortex–amygdala pathway is directly involved in the control of cardiovascular function^[27]. With regard to the “breath regulation” and “mind regulation” components, traditional Chinese health-preserving exercises seem capable of helping the prefrontal cortex to exert top-down inhibition of the amygdala—thus achieving a better autonomic nervous state while reducing kinesiphobia. Among the considerations connected with the DMN, traditional Chinese health-preserving exercises seem to help with self-reference and stress regulation, which may be achieved by means of optimized functional connectivity in, or between, DMN networks. Tai Chi users have distinctive resting-state functional connectivity patterns that seem to show how long-term practice may lead to functional specialization of the brain.

4.4. Behavioral mechanisms: Formation of an exercise habit, improved adherence, or greater social support

The group practice tradition—along with the sociocultural features—of traditional Chinese health-preserving exercises is helpful in producing certain behavioral effects. Of these, Tai Chi and Baduanjin are examples of exercises that have a very solid grassroots basis in China, and one may find that practice groups—whether held in a community or in a park—can provide social backing and peer encouragement. That kind of social support is helpful both in starting and in maintaining an exercise habit over time. Exercise self-efficacy—taken as a central psychological factor for exercise adherence—can be gradually improved through successful experiences of the “body regulation” item among the traditional Chinese exercises for health.

5. Theoretical logic: Why traditional Chinese health-preserving exercises are suitable for postoperative rehabilitation after cardiovascular surgery

5.1. Mind-body synergy: Treatment at once of certain physical and mental conditions

The main difficulty of postoperative rehabilitation following cardiovascular surgery is to be considered in connection with physiological dysfunction and psychological or behavioral disorders. Conventional rehabilitation programs often implement physiological training and psychological intervention separately, whereas the integrated triad model of “body regulation–breath regulation–mind regulation” in traditional Chinese health-preserving exercises deals at once with physiological function and psychological condition—both part of one training process. With regard to meta-analytic findings, traditional Chinese exercises that help to preserve one’s health may also improve cardiac function (LVEF rose by 6.20%) and are of considerable value in reducing anxiety or depression symptoms—this gives an opportunity to highlight the special value of mind-body synergy intervention ^[28].

5.2. Low-intensity safety: An option for high-risk cardiovascular populations

Patients who have undergone cardiovascular surgery are a high-risk population for exercise, with safety of the prescription as the main concern. For patients who have had AD surgery, it is necessary to avoid heavy isometric exertion or the Valsalva maneuver; in general, exercise intensity is best kept limited—ideally between 3 and 5 metabolic equivalents (METs). Among traditional Chinese forms of health-preserving exercise, the level of intensity is exactly to be found in the low-to-moderate category—i.e., the energy expenditure of Tai Chi is roughly 2.5–4.0 METs, and that of Baduanjin is about 2.0–3.5 METs—thereby satisfying the criterion of safe exercise (≤ 4.0 METs) and the intensity needs of groups with a high cardiovascular risk. On the other hand, traditional Chinese forms of health promotion make use of slow motions, little joint strain, and techniques adaptable to individual conditions, and offer high safety. A new multicenter RCT has preliminarily established the fact that moderate-intensity home-based exercise is safe in AD survivors in this regard; there is no higher risk of recurrent dissection or aortic surgery ^[14].

5.3. Cultural identity: High acceptance and accessibility among Chinese patients

Traditional Chinese practices for preserving one’s health rest upon Chinese culture and enjoy a long-established cultural foundation. With regard to the standard training and monitored exercise now known to be among Western models of cardiac rehabilitation, traditional Chinese health-preserving exercises seem to meet Chinese patients’ needs more readily and may be done independently—without medical supervision—in local communities and homes, with less need for medical help. Systematic reviews have pointed out that the important reasons for the low participation rate in cardiac rehabilitation in China are insufficient rehabilitation infrastructure and low patient recognition of exercise management ^[18], while the cultural affinity and low resource requirements of traditional Chinese health-preserving exercises can precisely compensate for these deficiencies ^[29,30].

5.4. Gradual adjustability: Adjustable intensity and duration according to individual conditions

Traditional Chinese health-preserving exercises possess good adjustability. Exercise intensity can be adjusted through movement amplitude, practice duration, and breathing depth, and the exercise format can be flexibly selected according to the patient’s physical fitness level and rehabilitation stage. This gradual adjustability

enables them to meet the needs of different rehabilitation stages after cardiovascular surgery, progressively transitioning from low-intensity breathing exercises and simple movements in the early postoperative period, to complete routine practice in the middle period, and then to maintenance training in the later period.

6. Special application logic concerning postoperative rehabilitation after AD

6.1. Particular features of postoperative rehabilitation after AD

Rehabilitation following an operation for acute Stanford type A aortic dissection (AD) presents special challenges. First, those who have AD must be kept under strict blood pressure control following surgery—so as to avoid recurrent dissection or progression of dissection. Second, patients have experienced life-threatening acute events and major traumatic surgery, and the postoperative kinesiophobia levels they show are very high—there is widespread confusion about “what exercise is safe and what intensity is appropriate.” Third, present-day guidelines do not specify any parameters for the prescription of exercise following AD surgery, which is a topic about which clinicians are somewhat uncertain. Fourth, patients after AD surgery have impaired long-term quality of life; compared with the general population, they score significantly lower on multiple dimensions of the 36-Item Short Form Health Survey (SF-36) and have higher bodily pain scores (Figure 2).

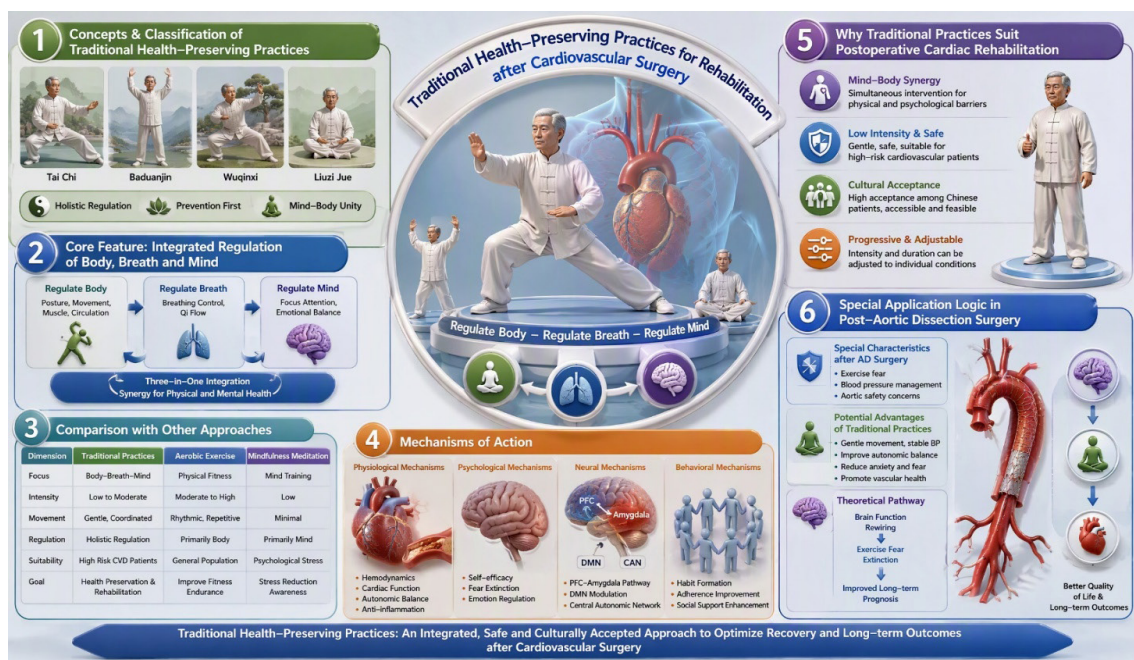


Figure 2. Traditional health-preserving practices for rehabilitation after cardiovascular surgery. AD, aortic dissection; CAN, central autonomic network; DMN, default mode network; PFC, prefrontal cortex.

6.2. Potential advantages of traditional Chinese health-preserving exercises after AD surgery

Traditional Chinese health-preserving exercises have multiple potential advantages in postoperative rehabilitation after AD surgery. First, with regard to the deep, prolonged abdominal breathing of the “breath regulation” component, it is possible to stimulate the parasympathetic nervous system—thus helping with

blood pressure and with autonomic balance. Second, the slow, rhythmic motions of the “body regulation” component avoid strenuous isometric exercise and the Valsalva maneuver—thereby meeting the safety requirements following AD surgery. Third, the kind of mindful attention given to the “mind regulation” part may be helpful in overcoming kinesiophobia and in bringing about a gradual return to exercise. Fourth, traditional Chinese health-preserving exercises are suited to non-medical environments—thereby lowering the threshold and cost of rehabilitation participation.

6.3. Theoretical pathway of “brain functional remodeling → extinction of kinesiophobia → improved long-term prognosis”

Based upon such an analysis, the present paper proposes a theoretical pathway for traditional Chinese health-preserving exercises in postoperative rehabilitation following AD surgery: through the three-dimensional synergy of “body regulation–breath regulation–mind regulation,” traditional Chinese health-preserving exercises help enhance functional connectivity of the prefrontal cortex–amygdala link and optimize DMN functional connectivity, thereby promoting brain functional remodeling; brain functional remodeling further enhances top-down inhibition of the amygdala by the prefrontal cortex and promotes the extinction of kinesiophobia; the extinction of kinesiophobia reduces avoidance of exercise, improves adherence to it and cardiopulmonary function, and so improves long-term prognosis (reduced MACE and enhanced quality of life). This theoretical pathway relates neural mechanisms to clinical outcomes and formulates—on that basis—a scientifically testable hypothesis for later study.

7. Research agenda

7.1. Theoretical model construction—conceptual framework and formulation of a hypothesis

Traditional Chinese health-preserving exercises—when considered as interventions—should be dealt with theoretically in future work on kinesiophobia following cardiovascular surgery. Let us now consider this model:

- (1) the relation between the components of intervention (body regulation, breath regulation, mind regulation) and the targets (cognitive, emotional, behavioral, or neural);
- (2) the mediating pathways and interaction effects between the various targets;
- (3) the influence of moderating variables—age, sex, kind of surgery, initial kinesiophobia level, etc.—with regard to intervention effects. To build a theoretical model, one has to combine several disciplines—psychology (the fear-avoidance idea, self-efficacy theory), neuroscience (circuits for fear extinction, CAN), and sports medicine (exercise prescription theory).

7.2. Validation of mechanisms: A study combining neuroimaging and cardiovascular tests

Validation of a mechanism is best carried out with multimodal neuroimaging techniques—such as resting-state functional magnetic resonance imaging (fMRI), diffusion tensor imaging (DTI), or task-related fMRI—to consider the regulatory effects of traditional Chinese health-promoting exercises with regard to the functional connectivity of the prefrontal cortex–amygdala pathway, the DMN, and the CAN. At the same time, cardiopulmonary exercise testing, ambulatory measurement of blood pressure, and analysis of heart rate variability are all worth combining to assess the link between variations in neural mechanisms and progress

in cardiovascular function. With regard to mediation analysis, a causal model of “changes in brain functional connectivity → changes in kinesiophobia scores → improvement in cardiopulmonary function” should be established.

7.3. Intervention research: Some important design elements for good RCTs

With regard to high-quality RCTs, the following items are worth considering:

- (1) clearly specifying inclusion and exclusion criteria to ensure homogeneous groups of participants;
- (2) adopting assessor-blinded and analyst-blinded arrangements;
- (3) choosing the Tampa Scale of Kinesiophobia Heart (TSK-SV Heart) as the primary outcome measure;
- (4) setting a sufficiently long follow-up period (of at least 12 months) to evaluate long-term prognosis;
- (5) strictly attending to safety and to adverse effects of the exercise treatment;
- (6) adopting a standardized teaching protocol for traditional Chinese health-preserving exercises—so as to ensure homogeneity and reproducibility of the treatment.

7.4. Guideline translation: With an eye to evidence and clinical recommendations

One must now consider how to encourage, on the part of medical authorities, the use of traditional Chinese methods of health preservation in guidelines for post-cardiac surgery care. The following is needed:

- (1) the establishment of standardized protocols for traditional Chinese methods of health maintenance in postoperative cardiovascular rehabilitation—specifically, the choice of exercise and intensity grading, with details about suitable frequency and duration;
- (2) specifying contraindications and the standards of safety monitoring;
- (3) making health economic assessments—i.e., analyses of the cost-effectiveness of traditional Chinese health-preserving forms of exercise rehabilitation;
- (4) strengthening the training of clinicians—so as to raise their awareness and readiness to recommend traditional Chinese forms of exercise for health purposes.

8. Conclusion

Traditional Chinese health-preserving exercises, characterized by the integrated triad of “body regulation–breath regulation–mind regulation,” have a well-organized theoretical basis as well as wide room for application in postoperative rehabilitation after a cardiovascular operation. Their various mechanisms of action can be considered at four levels—physiological, psychological, neural, and behavioral. At the physiological level, they may improve hemodynamics, cardiac performance, and autonomic nervous balance. At the psychological level, they may help to raise self-efficacy with regard to exercise, promote fear extinction, and regulate emotions. From a neural standpoint, they can promote functional connectivity of the prefrontal cortex–amygdala pathway and work toward optimizing DMN functional connectivity. From a behavioral point of view, they may help to form exercise habits or to maintain them. Traditional Chinese methods of health preservation are particularly well adapted—among other things—to post-cardiac-surgery rehabilitation; their advantages—mind-body interaction, low-intensity safety, cultural identity, and gradual adjustability—render them especially suitable for rehabilitation following high-risk cardiovascular operations such as AD. It is now time to plan systematically four future directions: theoretical models, multimodal neuroimaging validation of mechanisms, good-quality RCT designs, and guidelines—so as to establish

an unambiguous evidence base that supports standardization of traditional Chinese methods of health preservation in postoperative rehabilitation following cardiovascular surgery.

Funding

Hunan Provincial Degree and Postgraduate Teaching Reform Research and Postgraduate Scientific Research Innovation Project (Project No.: 2025JGYB286)

Disclosure statement

The authors declare no conflict of interest.

References

- [1] Li P, Zhang HP, 2025, From Surgery to Recovery: Measuring Success Through Quality of Life and Functional Improvements After Cardiac Surgery. *World J Cardiol*, 17(2): 100213.
- [2] Takino K, Kuze Y, Nagai T, et al., 2026, Prediction of Exercise Intolerance in the Recovery Period After Cardiovascular Surgery Using Perioperative Clinical Parameters. *Arch Phys Med Rehabil*, 2026 Jul 12: S0003-9993(26)00814-2.
- [3] Wang Y, Cao J, Kong X, et al., 2021, The Effects of CPET-Guided Cardiac Rehabilitation on the Cardiopulmonary Function, the Exercise Endurance, and the NT-proBNP and hs-cTnT Levels in CHF Patients. *Am J Transl Res*, 13(6): 7104–7114.
- [4] Chen Y, Hu W, Tan L, et al., 2026, Relationship Between Postoperative Pain in Surgery and the Onset of Psychological Symptoms Such as Mental Anxiety and Depression. *Actas Esp Psiquiatr*, 54(3): 786–796.
- [5] Luo Q, Guo X, Xu Y, et al., 2026, Distinct Kinesiophobia Profiles and Associated Factors in Patients Undergoing Coronary Artery Bypass Grafting. *Front Psychol*, 17: 1702153.
- [6] Chen Y, Guo H, Peng Y, et al., 2025, The Latent Class and Influencing Factors of Kinesiophobia in Patients After Cardiac Surgery With Cardiopulmonary Bypass: A Prospective Longitudinal Study. *J Psychosom Res*, 196: 112310.
- [7] Liang J, Tan X, Li Y, et al., 2025, Contextual Barriers and Facilitators to Exercise-Based Cardiac Rehabilitation in China: A CFIR 2.0-Guided Systematic Review of Policy, Cultural, and Organizational Determinants. *J Multidiscip Healthc*, 18: 8067–8080.
- [8] Bryant J, Rubenfire M, Katona AM, et al., 2021, Increasing Cardiac Rehabilitation Participation Through a “Nearer to Home” Patient Referral Program. *J Cardiopulm Rehabil Prev*, 41(1): E1–E4.
- [9] Liu J, Yu H, Jan YK, 2026, A Systematic Review and Meta-Analysis of the Mechanism of Action of Tai Chi on Cardiovascular Disease: Evidence Map of Aerobic and Mind-Body Exercise Pathways. *Sci Rep*, 16(1): 6708.
- [10] Han Y, Sun W, Han J, et al., 2026, Effects of Six Traditional Chinese Mind-Body Exercise Therapies on Vascular Health and Cardiac Function in Middle-Aged and Elderly Hypertensive Patients: A Network Meta-Analysis of 48 Randomized Controlled Trials. *Ageing Res Rev*, 115: 103007.
- [11] Tsai YN, Chang YH, Su YC, et al., 2026, A Community-Based Daoyin Program for Health Promotion: Effects of the Qi and Mind Harmonizing Method on Body Constitution for the Health of Older Adults. *Front Public Health*, 13: 1644273.
- [12] Dong W, Zheng T, Wu P, et al., 2026, Elderly Tai Chi Practitioners Exhibit Superior Multisensory Integration in a Dual-Task Paradigm. *Front Hum Neurosci*, 20: 1776363.

- [13] Le François T, Hilberdink CE, Guillery-Girard B, et al., 2026, Exploring the Effects of Mindfulness Meditation on Resting-State Functional Connectivity: An Overview. *Rev Neurosci*, 2026 Jun 3.
- [14] Kobayashi K, 2026, Exercise-Based Cardiac Rehabilitation After Aortic Dissection: A Systematic Review of Exercise Prescription and Blood Pressure-Guided Management. *Heart Vessels*, Advance Online Publication.
- [15] Zeng Z, Shen Y, Wan L, et al., 2024, Kinesiophobia in Patients After Cardiac Surgery: A Scoping Review. *BMC Cardiovasc Disord*, 24(1): 469.
- [16] Wu JH, Wu JM, Liu B, et al., 2026, Facilitators and Barriers to Exercise Adherence in Patients With COPD: A Qualitative Study Guided by the Fear-Avoidance Model. *Chron Respir Dis*, 23: 14799731261480690.
- [17] Slovinc D'Angelo ME, Pelletier LG, Reid RD, et al., 2014, The Roles of Self-Efficacy and Motivation in the Prediction of Short- and Long-Term Adherence to Exercise Among Patients With Coronary Heart Disease. *Health Psychol*, 33(11): 1344–1353.
- [18] Hu SS, 2024, Rehabilitation of Cardiovascular Diseases in China. *J Geriatr Cardiol*, 21(11): 1003–1014.
- [19] Carbone A, Lamberti N, Manfredini R, et al., 2024, Cardiac Rehabilitation and Acute Aortic Dissection: Understanding and Addressing the Evidence Gap—A Systematic Review. *Curr Probl Cardiol*, 49(3): 102348.
- [20] Ades PA, Keteyian SJ, Wright JS, et al., 2017, Increasing Cardiac Rehabilitation Participation From 20% to 70%: A Road Map From the Million Hearts Cardiac Rehabilitation Collaborative. *Mayo Clin Proc*, 92(2): 234–242.
- [21] Nowak J, Listewnik M, Rył A, et al., 2025, Rehabilitation Progress in Patients Following Surgery for Acute Stanford Type A Aortic Dissection Extending Beyond the Ascending Aorta. *J Clin Med*, 14(1): 197.
- [22] Liang SB, Li YF, Zhang YY, et al., 2026, Is Baduanjin Beneficial and Safe for the Rehabilitation of Patients With Acute Myocardial Infarction Undergoing Percutaneous Coronary Intervention? A Systematic Review and Meta-Analysis of Randomised Controlled Trials. *Complement Ther Med*, 98: 103345.
- [23] Chen Y, Zuo X, Tang Y, et al., 2024, The Effects of Tai Chi and Baduanjin on Breast Cancer Patients: Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Front Oncol*, 14: 1434087.
- [24] Takroni MA, Thow M, Ellis B, et al., 2022, Home-Based Versus Outpatient-Based Cardiac Rehabilitation Post-Coronary Artery Bypass Graft Surgery: A Randomized Controlled Trial. *J Cardiovasc Nurs*, 37(3): 274–280.
- [25] Han YMY, Chan MMY, Choi CXT, et al., 2023, The Neurobiological Effects of Mind-Body Exercise: A Systematic Review and Meta-Analysis of Neuroimaging Studies. *Sci Rep*, 13(1): 10948.
- [26] Jin X, Chen J, Zhang X, 2026, Tai Chi Exercise and Neuroplasticity: A Narrative Review According to Neural Mechanisms and Clinical Utilizations in Brain Health. *Front Neurosci*, 20: 1769779.
- [27] Ma L, Keen LD 2nd, Steinberg JL, et al., 2024, Relationship Between Central Autonomic Effective Connectivity and Heart Rate Variability: A Resting-State fMRI Dynamic Causal Modeling Study. *Neuroimage*, 300: 120869.
- [28] Shi F, Yu J, Wang H, Wu C, 2024, The Impact of Various Mind-Body Exercises on Cardiorespiratory Function and Quality of Life in Heart Failure Patients: A Network Meta-Analysis. *Curr Probl Cardiol*, 49(12): 102881.
- [29] Imran HM, Baig M, Erqou S, et al., 2019, Home-Based Cardiac Rehabilitation Alone and Hybrid With Center-Based Cardiac Rehabilitation in Heart Failure: A Systematic Review and Meta-Analysis. *J Am Heart Assoc*, 8(16): e012779.
- [30] Blair J, Corrigan H, Angus NJ, et al., 2011, Home Versus Hospital-Based Cardiac Rehabilitation: A Systematic Review. *Rural Remote Health*, 11(2): 1532.

Publisher's note

Bio-Byword Scientific Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.