

STUDY PROTOCOL

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The influence of different intensity of Tan Tui exercises on the posture control of students in the Tai Chi Elective Course: protocol for a randomized controlled trial

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Abstract

Background Tai Chi (TC) holds a unique and valued place in promoting the physical and mental health of college students. Its significance is underscored by its incorporation as a compulsory physical education course in every university in China. TC, with its rich tradition, places a strong emphasis on posture control as a core sports ability. However, the students in Tai Chi Elective Course (TCEC) have very poor posture control ability. This study protocol investigates the potential of Tan Tui (TT) to address these issues, as TT is a fundamental skill for beginners of traditional Chinese martial arts and has a track record of enhancing lower limb strength and balance, making it a promising choice for improving posture control in TCEC.

Methods/design To investigate the impact of different intensities of TT exercises on posture control in TCEC students, we have designed a randomized, double-blind, parallel-controlled trial. Seventy-six students in the TCEC will be randomly divided into low-intensity Tan Tui (LTT), medium-intensity Tan Tui (MTT), and high-intensity Tan Tui exercises group (HTT) and control group (CON), each with 19 people. The LTT group, MTT group, and HTT group will be given different intensity of TT exercises, and the CON group will be given regular TCEC. The intervention period will be 6 weeks (2 times a week, 20 min each time). At baseline (before), 4 weeks of intervention (middle), and 6 weeks of intervention (after), the Unipedal Stance Test (UST), the Star Excursion Balance Test (SEBT), 60°/s angular velocity knee joint flexion and extension relative peak torque (RPT), and knee joint position perception (KJPP) will be evaluated.

Discussion This is the first randomized controlled trial protocol from the perspective of training intensity to evaluate the effect of different intensity of TT exercises on posture control of students in TCEC. Should our research reveal a significant intervention effect, the results will offer preliminary, higher-quality evidence supporting the positive impact of varying intensities of Tan Tui exercises on posture control in TCEC students.

Trial registration Chinese Clinical Trial Registry ChiCTR2000039109. Registered on October 17, 2020.

Keywords Tan Tui exercises, Posture control, Tai Chi Elective Course, College students, Randomized controlled trial

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Background

Tai Chi (TC), a revered form of martial arts in China's traditional national sports, embodies the essence of traditional body culture. Numerous scholars, both domestically and abroad, have confirmed its significant value



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in promoting human health [1], aiding physical function recovery [2], facilitating the recovery of chronic diseases [3], treating sports injuries [4], and providing psychological cognitive interventions [5]. Foreign scholars pay attention to the medical and medicinal auxiliary value of TC from the perspective of physical and medical integration, while domestic scholars pay attention to the fitness value of TC from the perspective of sports [6]. In colleges and universities, the Tai Chi Elective Course (TCEC) serves as a crucial vehicle for disseminating TC's health culture value and promoting the physical and mental well-being of students. Research shows that TCEC can significantly improve college students' cognition [7], depression [8], balance, and other conditions [9], which is of great significance to college students' physical and mental health. However, the practical effect of students in the Tai Chi Elective Course (STCEC) is worrying. Studies indicate that college students in TCEC begin with strong motivation but tend to lose it as the learning process progresses, often discontinuing practice after the course. The reason for this "embarrassing phenomenon" may be that the teaching of TCECs is just the teaching of TC movements and the imitation of martial arts routines [10]. At the same time, the decline of college students' physical health has made it difficult for them to meet the specific physical needs of TC, which affects the teaching effect of TC and students' interest in practice.

The posture control ability of college students in the state of one leg support is the basic exercise ability of practicing TC [11]. Therefore, enhancing college students' posture control abilities holds tremendous importance for their TC practice [12, 13]. Most foreign studies focus on the rehabilitation effect and mechanism of TC on patients. For example, *New England Journal of Medicine* pointed out that TC can improve muscle fiber pain [1]. At the same time, it can improve the postural control ability of football players [9], and then improve their football performance. STCEC, as enthusiasts of TC, should adopt simple, easy to learn, and convenient exercise methods to improve their posture control ability. Tan Tui (TT), known as the "Introduction of TT," serves as a foundational skill for introducing traditional Chinese martial arts. Its key features include speed, symmetry, simplicity, and ease of learning [14]. TT not only plays a significant role in enhancing beginners' physical qualities, particularly lower limb strength and balance, but also in stabilizing footwork, enhancing flexibility in the upper limbs and waist, and promoting overall body development in a balanced, calm, and coordinated manner [15, 16]. It plays an important role in body posture control. It is pointed out in the martial arts classics of ancient Chinese medicine that the effect of the TT is "long

strength, steady style, practical, and firm bones," which can significantly improve the lower limb strength and balance ability of practitioners [17]. Professor Zhang Wenguang also pointed out in his book for the TT that the TT has a good impact on human strength, speed, stability, and other abilities [18]. It can be seen that catapult is an effective means to improve the posture control ability of ordinary people.

In this study, the different intensity TT exercise will be integrated into the warm-up activity of TCEC, and the different intensity TT exercise will be used as the intervention methods. The STCEC is taken as the study objects to evaluate the effects of different intensity TT exercise on the static balance, dynamic balance, knee muscle strength, and proprioception related to the posture control of college students. This evaluation aims to provide a theoretical reference for enhancing posture control among students in Tai Chi elective courses and improving the effectiveness of their TC practice. Additionally, this study will contribute to the wider social promotion of TC and better utilization of its health promotion and patient rehabilitation benefits through adult exercise, potentially reducing related medical costs.

Methods/design

Study purposes

The objective of this protocol is to examine the efficacy of different intensity TT exercises for 6 weeks on posture control of STCEC.

Study design

This study is designed as a randomized, parallel controlled, double-blind trial. The research framework type is superior. Seventy-six eligible STCEC will be recruited and randomly allocated into four groups: low-intensity Tan Tui (LTT) group, medium-intensity Tan Tui (MTT) group, high-intensity Tan Tui exercises group (HTT) group, and CON group, with a ratio of 1:1. LTT group will receive low-intensity TT exercise; MTT group will receive medium-intensity TT exercise; HTT group will receive high-intensity TT exercise; CON group had regular jogging and free hand exercises. The intervention period of the four groups will be 6 weeks, with 20 min of practice twice a week. The relevant outcome indicators will be measured at the baseline, mid-intervention (4 weeks), and late intervention (6 weeks) to check the maintenance of any intervention effect. The participant flow for this trial is presented in Fig. 1. The present protocol follows the Standard Protocol Items: Recommendations for Interventional Trials (SPIRIT) guidelines and fulfills the SPIRIT checklist (see Additional file 1).

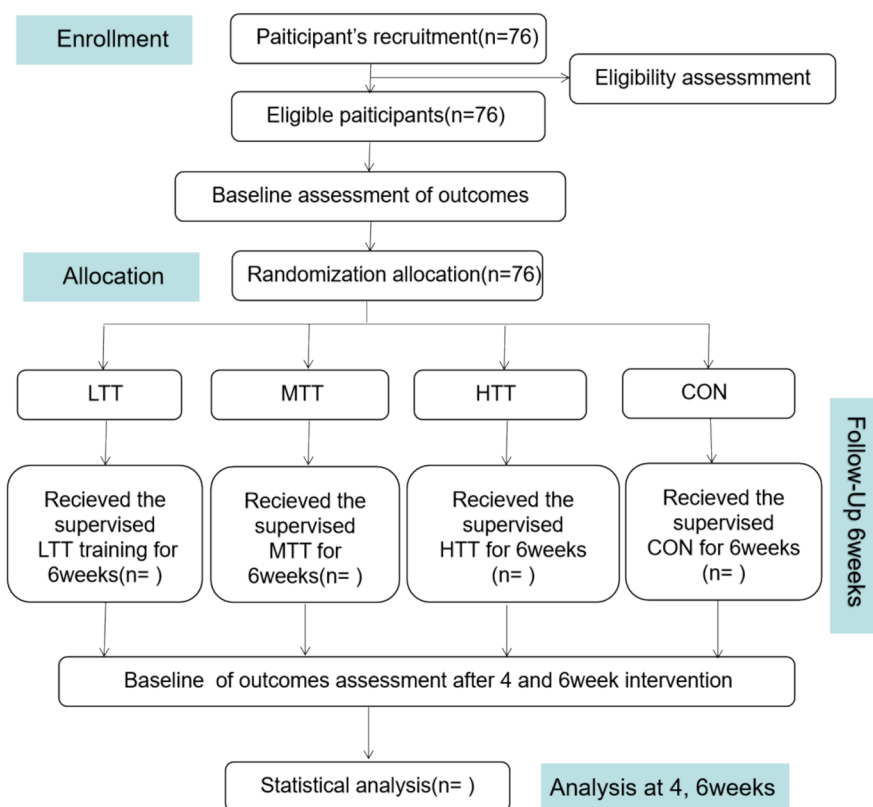


Fig. 1 Proposed participant flow. LTT, low-intensity Tan Tui; MTT, medium-intensity Tan Tui; HTT, high-intensity Tan Tui; CON, control group

Sample size calculation

The sample size is calculated by the software G * Power 3.1.9 for Windows (G * Power © from the University of Dusseldorf, Germany) [19]. The calculation of sample size is regarded as the calculation of power, and its purpose is to evaluate whether there is significant difference in outcome indicators. The experimental design of 4 (groups) * 3 (time) in this study has a statistical power of 80% and a type I error probability (α) which is 0.05. The statistical analysis method is mixed ANOVA. In the pre-experiment, based on the research results of dynamic equilibrium, the obtained effect size was 0.25. The total sample size calculated by the software is 64 participants, with 16 participants in each group. At the same time, considering the 15% dropout rate and the proportionality between groups, the sample size is 76 participants in total, with 19 participants in each group.

Setting and recruitment

The research will recruit participants from a university in Beijing, China, through WeChat, flyers, and microblogs. The intervention will be independently guided by three research assistants from the university, while data collection will be conducted by separate research assistants.

Due to the impact of the COVID-19, this study will officially start recruitment in March 2023.

This experiment does not include collecting biological specimens for storage.

Participant eligibility

The inclusion criteria of the subjects are as follows: (1) ordinary college students aged 18–28; (2) STCEC; (3) healthy, without sports contraindication; and (4) voluntary and signed informed consent. Criteria for exclusion from the study are as follows: (1) inability to bear the load intensity of the TT exercise; (2) history of injury or surgery in the past 6 months; and (3) having had severe cardiovascular diseases and musculoskeletal system diseases. Before the intervention, all subjects voluntarily will sign a written informed consent form and receive the researcher’s explanation of the research process, strictly following the ethical standards of the Helsinki Declaration.

Randomization, allocation, and blinding

The random allocation sequence will be generated by an independent statistician via the SPSS (IBM. Version 20.0) software program. The subjects who had signed the “informed consent form” will be assigned to ensure that

the grouping was hidden. The subjects will be randomly divided into four groups: LTT ($n=19$), low-intensity TT exercise; MTT ($n=19$), middle strength TT exercise; HTT ($n=19$), high-intensity TT exercise; and CON ($n=19$), jogging and free hand exercises.

In this study protocol, the subjects are already practicing TC as part of their normal study and training routine. Data collection and statistical analysis will be exclusively conducted by three research assistants who are not involved in coaching, ensuring the blinding of coaches and statisticians. The grouping of subjects was completed by two research assistants who did not participate in sports intervention and data. Before the end of the intervention, the subjects, coaches, and statistical analysts will not be informed of any information about the grouping. The statistical analysis shall be conducted by individual personnel who do not participate in the test. The grouping results will be published after the completion of all statistical data analysis to complete the unblinding.

Intervention

This randomized controlled trial strictly adheres to the Comprehensive Standards for Reporting Trials (CONSORT) guidelines for non-drug therapy trials [20]. The four different interventions spanned a 6-week period, with sessions held twice a week, each lasting 20 min. The intervention exercise will be completed in the warm-up part of the TCEC. The aim of this intervention was to enhance the subjects' posture control abilities, providing support for their TC learning and technical improvement.

Selection of TT exercise movements: The selection of TT exercises combined with the physiological characteristics and physical fitness status of STCEC, through the classified statistics of the ten ways of TT exercises [18] compiled by Professor Zhang Wenguang, the bow step type movements and TT exercises accounted for 61% and 17% respectively, accounting for 78% of the total ten ways of TT exercises. Therefore, this study selects from the lunge movements and the TT movements. The TT exercises include three parts: (1) preparatory movements: parallel standing, lunge fist clasp, and lunge fist punching; (2) TT exercises: right cross fist, right smashing fist, right bouncing leg, right lunge punching, left cross fist, left smashing fist, left bouncing leg, and left lunge punching; and (3) closing movement: stand in parallel (Fig. 2).

Division of the intensity of the TT exercise

The TT exercise protocol is designed according to the standard exercise forms of the TT in the training practice and the previous literature on the TT exercise methods [18, 21, 22]. Through the pre-experiment, we used a heart

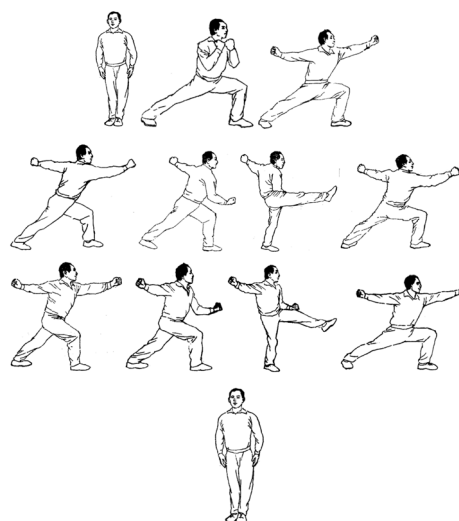


Fig. 2 TT training movement [18]

rate meter (Polar RS800) to monitor the intensity of the TT exercise and combined with the characteristics of the TCEC. According to the classification criteria of the exercise intensity, lower than 60% HRmax is low-intensity exercise, 60~80% HRmax is medium-intensity exercise, and higher than 80% HRmax is high-intensity exercise [23]. Therefore, the average heart rate of the eight typical movements of the TT was measured according to different slow rhythms. Finally, it is determined that each movement is stationary for 1 s, 3 s, and 5 s. Eight movements are taken as one set, and four movements are repeated continuously as one group, that is, 32 1-s movements are LTT, 32 3-s movements are MTT, and 32 5-s movements are HTT.

TT exercise protocol

Aligned with the regular TCEC schedule in colleges and universities, participants engaged in TT exercises twice a week for 20 min each time, with the exercise phase integrated into the warm-up portion. The total intervention time was 6 weeks, which was divided into two stages: movement learning in the first 2 weeks, followed by 4 weeks of movement improvement [18] (Table 1).

Requirements for the movement of the TT exercise

During each movement of the TT, attention should be paid to the coordination of the movement's strength and breathing. Emphasize the generation of lower limb power, starting from the root, progressing through the middle, and extending forward. The breathing follows the principles of "lifting air" and "supporting air" [24]. Regarding technical movement standards, the bow stance follows the competition rules of martial arts taolu [25].

Table 1 TT teaching plan [18]

Teaching stage	Time	Aim	Specific teaching content
Movement learning stage	2 weeks	Learn new movements under the teacher's guidance	The first week they learned and were able to complete sets of movements independently. The second week they repeated the movements to basically meet the specification requirements of each movement
Movement improvement stage	4 weeks	The groups of different intensities were repeated to improve their postural control ability	LTT group: each movement is still for 1 s, 8 movements are one set, each group repeats 4 sets, a total of 3 groups are conducted, the interval between groups is 1 min, each exercise time is about 5 min, and the rest 15 min is for bare handed exercise and stretching exercise MTT group: each movement is still for 3 s, 8 movements are one set, each group repeats 4 sets, a total of 3 groups are conducted, the interval between groups is 2 min, each exercise time is about 10 min, and the rest 10 min is for bare handed exercise and stretching exercise HTT group: each movement is still for 5 s, 8 movements are one set, each group repeats 4 sets, a total of 3 groups are performed, the interval between groups is 3 min, each exercise time is about 15 min, and the rest 5 min is stretching exercise

In terms of the technical movements, the support leg is required to be upright, the spring kick is level with the ground, and the support leg and the pop-up leg are kept at about 90°.

CON group exercise protocol

Conduct regular warm-up exercises in the warm-up activity stage of TCEC, mainly including 2 min jogging, 3 min free hand exercise, 10 min “chase” game, 3 min flexibility exercise, and 2 min standing stake (TC Zhuang) breath regulation exercise. Each exercise session lasts for 20 min, conducted twice a week over a 6-week period.

Outcome assessment

Primary outcome

Static balance

The static balance ability of the dominant side of the subject was evaluated by the Single Stand Test (UST) with eyes closed. In this test, participants stood on one foot with their eyes closed and the timer stopped when there was any support leg displacement, eye opening, or non-support leg touching the ground [26]. Each subject repeats the test for three times with a rest interval of 20 s. The mean of the three test scores is the final test score of the subject.

Dynamic balance

SEBT was used to evaluate the dynamic balance ability of the dominant side of the subjects. SEBT is a comprehensive quality including strength, flexibility, and

coordination, which is widely used to evaluate the dynamic stability of lower limbs [27]. Its testing method refers to previous research [28]. Before the formal test, participants performed four practice exercises to reduce the impact of the learning effect. In the formal test, the subjects stood on one foot with both hands on their hips, extending the non-support leg as far as possible to the front, back inside, and back outside of the support leg, and then retract and close to the support leg, and then start the next extension. The subjects measured three times in each direction with a 20-s rest interval between each trial. The average of the three test data is the final score of the subjects in that direction, and the total value is the average of the three directions.

Isokinetic muscle strength test of knee joint

Isomed 2000 isokinetic muscle strength test system of Germany was used to test the isokinetic muscle strength evaluation of the dominant knee joint of the subject [29]. After the subject has warmed up sufficiently, the tester will guide the test and conduct adaptability exercises on the test system. In the formal test, a sitting position is used to fix the thigh and trunk. The range of knee joint motion angle is set to be 0–100°, and the test angular velocity is 60°/s. Research shows that the angular velocity can better reflect the level of knee joint flexor and extensor muscle force [30]. The knee joint flexion and extension test shall be conducted for 5 times respectively. The flexor muscle shall be tested first, then the extensor muscle, and the dominant leg shall be tested first, then the

weak leg. The interval between each test shall be 60 s, and the average value shall be taken as the final test result. The test index is RPT, representing the peak torque per unit weight. The larger the RPT value, the greater the knee muscle strength.

Secondary outcomes

Knee proprioception test

The KJPP evaluation of the dominant side of the subject was tested with the Isomed 2000 isokinetic muscle force test system in Germany. The knee joint position sense test adopts the passive position sense reduction method with the target angle set at 45° of knee joint flexion [31]. During the formal test, the knee joint of the subject is driven by the instrument to the target angle, and then the subject carefully feels the angle for 5 s and returns to the starting position. Subsequently, the instrument moved the knee joint at a speed of 1°/s, and the subject had to press the brake switch when they felt the target angle had been reached. The position perception of the subject is the absolute value of the difference between the actual angle of reset and the target angle. The smaller the value, the better the position perception.

Safety measurements

Any unexpected adverse events (AEs) that occurred during the 6-week intervention period will be reported to the research assistant, and the causal relationship between the different intensity of TT exercises and the subjects will be evaluated. In case of serious sports injury or other AEs, the research assistant will immediately report to the project manager and the Sports Science Ethics Committee of Beijing Sport University. They will decide whether participants need to withdraw from the study.

Data collection

Demographic information of subjects will be collected during the recruitment process. The data of primary and secondary outcome indicators will be collected by special assessors at baseline, 4 weeks of intervention, and 6 weeks of intervention. All outcome assessors will receive standardized training on measuring all outcomes before intervention to ensure that all subjects have similar test conditions.

In order to encourage participant retention and complete data, participants received free coaching sessions from the TT champion and a ¥200 reward through WeChat upon completing the 6-week intervention.

Data management

The primary and secondary outcome indicators of the test will be recorded through the case report form (p-CRF), and the paper version data will be processed

electronically through the free data management software EpiData Manager in a timely manner. The two data assessors independently reviewed and confirmed the data and converted it into a format that can be used for statistical analysis.

Statistical analysis

The Statistical Package for Social Sciences (SPSS 23, SPSS Inc., Chicago, IL, USA) is used for statistical analysis. Descriptive statistical analysis is described in the form of mean \pm standard deviation. Shapiro–Wilk was used to test whether the variables conform to normal distribution. Single factor multiple analysis of variance was used to compare whether the basic information (age, height, weight, leg length data) of subjects before intervention was homogeneous. The effects of intervention groups (such as LTT, MTT, HTT) and time (such as before, during, and after intervention) were analyzed by mixed two-factor multiple analysis of variance. Multiple comparisons were made among the variables with significant results of square error analysis by post-analysis and Bonferroni correction. The effect size is calculated according to Cohen's method, which divides the effect size into large (0.8), medium (0.50–0.79), and small (0.20–0.49) [32]. The alpha level for all tests is set to 0.05.

Ethics

The research will be conducted in accordance with the principles of the Helsinki Declaration and relevant ethical standards, including informed consent, confidentiality, and data storage. Ethics has been approved by the Ethics Committee of Sports Science Experiment of Beijing Sport University (Approval No. 2020123H). All participants will be fully informed of the test and sign the informed consent form before participating.

Monitoring

TT is an aerobic sport, belonging to the traditional Chinese national sports, which is easy to learn and low risk. No Data Monitoring Committee, interim analyses, or stopping rules were deemed necessary due to the expected minimal potential harm.

Dissemination

The study protocol has been registered and can be viewed on the Chinese trial registration website (registered in ChiCTR.org, with the identifier of ChiCTR2000039109). The research results after the experiment will be disseminated to all participants, researchers, healthcare providers, and sponsors through research summary documents, courses, presentations, and the Internet. The study will also be published in scientific journals and presented at the conference, targeting a wide range of groups.

Discussion

Tan Tui (TT) stands as a quintessential form within the spectrum of traditional Chinese martial arts. It serves as the foundational training method for martial arts practitioners, representing a universal starting point for mastering this ancient art. However, international research focusing on Tan Tui is relatively scarce, with existing studies primarily centered on its technical system [33] and historical origins [15]. The exploration of TT's impact on posture control among diverse individuals remains a relatively uncharted territory. The latest research shows that the acute effect of the springing leg on the explosive force of the lower limbs of high school students has a significant impact [34]. The research divides the springing leg exercise into experimental group A (with the intensity of 40–50% HRmax), experimental group B (with the intensity of 60–70% HRmax), and experimental group C (with the intensity of 75–85% HRmax). The explosive force index is tested before and after the intervention at 4, 8, 12, and 16 min. The results show that the middle and high intensity (60–85% HR max) load of the TT exercise can produce a post activation enhancement effect on the explosive force of the lower limbs of high school students. Based on the positive effects on the strength and stability of human lower limbs in the books and experimental research on the TT, this study will use the TT exercise (LTT, MTT, HTT) for STCEC to try to improve their posture control ability and improve the effect of college students' learning TC.

At present, we have not found the effect of different intensity of TT exercise on the posture control of STCEC. In this study protocol, we will evaluate the influence of 6 weeks of different intensity TT exercises (LTT, MTT, HTT) on the posture control of STCEC. Strict random grouping method, double blind experiment design, and scientific data collection and statistics methods are adopted in this test scheme to minimize the test error. It is expected that this test will produce reliable results.

This study has some potential limitations. Due to the unexpected events such as the conflict between the training time and other commitments, sports injury, and bad weather, the possibility of the participants with different intensity of the TT continuing to adhere to the intervention plan is another problem affecting this study. At the same time, the global impact of COVID-19 has had deep-reaching consequences, possibly leading to the temporary suspension of Tai Chi courses for Chinese college students. This, in turn, could impede both subject recruitment and intervention training. As the COVID-19 situation evolves, our study will adapt accordingly.

Trial status

The experiment is in progress. Recruitment will begin in March 2023 and end in May 2023. The experiment procedure is expected to be completed by the end of December 2023.

Abbreviations

STCEC	Students in the Tai Chi Elective Course
TC	Tai Chi
TT	Tan Tui
TCEC	Tai Chi Elective Course
LTT	Low-intensity Tan Tui
CON	Control group
MTT	Medium-intensity Tan Tui
HTT	High-intensity Tan Tui
UST	Unipedal Stance Test
SEBT	Star Excursion Balance Test
RPT	Relative peak torque
KJPP	Knee joint position perception
AEs	Adverse events

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s13063-024-08447-5>.

Additional file 1. SPIRIT checklist.

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Authors' contributions

LHX (CA) was involved in the conception and design of the research. LYH obtained ethics approval. LYH drafted the manuscript. MSY and ZWJ participated in Chinese and English text correction and language modification. The change of the corresponding author is that during the research process, YZM provided constructive suggestions for this research and also provided financial support. All authors edited and revised the manuscript. All authors approved the final version of the manuscript.

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Availability of data and materials

Data for the study can be made available upon request. Interested researchers should contact Dr. Li at li2513436@126.cm.

Declarations

Ethics approval and consent to participate

The study protocol has been approved by the Sports Science Experimental Ethics Committee of Beijing Sport University (approval number 2020123H). Signed consent forms will be obtained from all participants prior to their participation in the trial.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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