Study Protocol for Retrospective Registration

Enhancing balance, agility and strength in amateur badminton players using a novel badminton-specific square-stepping exercise (bs-SSE)

Important note. This protocol reformats a completed quasi-experimental study for retrospective registration. Fields not reported in the manuscript are flagged for investigator confirmation.

Administrative information

Protocol version	Version 1.0
Protocol date	March 31 2026
Study status	Completed study; final analysis already conducted
Registration status	Prepared for retrospective registration
Design	Two-arm, parallel-group, quasi-experimental intervention study
Ethics approval	University Research Ethics Committee, INTI-IU/FHLS-RC/BPHTI/7NY12022/020
Funding	No funds, grants or other support declared
Data availability	Available upon reasonable request to the corresponding author
Protocol source	Reformatted from the revised manuscript supplied by the investigators

Registration-oriented summary

Scientific title	Enhancing balance, agility and strength in amateur badminton players using a novel badminton-specific square-stepping exercise (bs-SSE)
Public title	Badminton-specific square-stepping exercise to improve balance, agility and ankle strength in amateur badminton players
Health condition / focus	Physical performance in amateur badminton players (dynamic balance, agility, and ankle strength)
Setting	Amateur badminton players in Malaysia
Participants	Adults aged 18–40 years with at least 5 years of badminton experience and current participation of 2–4 hours per week
Intervention	Eight-week badminton-specific square-stepping exercise programme delivered on a 2.5 m × 1.0 m mat divided into 40 squares
Comparator	Usual activity with no additional structured bs-SSE programme
Assessment schedule	Baseline, week 4 and week 8
Outcome domains	Dynamic balance, agility, and ankle dorsiflexor/plantar flexor strength
Sample size	66 participants recruited; 32 participants allocated (16 per group) and analyzed

Protocol summary

Background: Badminton involves repeated accelerations, lunges, landings and directional changes, placing high demands on balance, agility and ankle function. Amateur players may not routinely receive structured sport-specific conditioning.

Objective: To evaluate whether an eight-week bs-SSE programme improves dynamic balance, agility and ankle strength in amateur badminton players.

Design: Retrospectively documented quasi-experimental study with assessments at baseline, week 4 and week 8.

Methods: Eligible participants were allocated to an intervention group receiving bs-SSE or a control group continuing usual activity. Outcomes were measured with the Y-Balance Test, Agility T-test and handheld dynamometry.

Completed-study status: The study has been completed and analysed. This document restates the original study methods in protocol format for retrospective registration.

Background and rationale

Badminton is a demanding racquet sport characterised by rapid changes of direction, repeated lunges, jumping, landing and complex footwork. These actions require efficient postural control, neuromuscular coordination and lower-limb force production.

Dynamic balance is central to effective rally movement because players must control their centre of mass while accelerating, decelerating and recovering across the court. Agility is equally important because successful play depends on fast, accurate multidirectional movement. The ankle complex contributes substantially to propulsion, stability and controlled landing, while also representing a common site of injury in amateur badminton players.

The badminton-specific square-stepping exercise (bs-SSE) programme was designed to combine progressive multidirectional stepping patterns with badminton footwork demands in a structured format suitable for amateur players.

Objectives and study hypothesis

The objective was to determine whether an eight-week bs-SSE programme could improve physical performance domains relevant to badminton in amateur players.

The study evaluated changes in dynamic balance, agility and ankle strength over time and compared those changes between the intervention group and the control group.

The hypothesis was that participants receiving bs-SSE would improve more than those continuing usual activity.

Methods

Study design

This was a two-arm, parallel-group, quasi-experimental intervention study with repeated assessments at baseline, week 4 and week 8. Because the source manuscript describes group assignment without confirming randomisation, the study is documented here as non-randomised.

Participants and eligibility criteria

- Inclusion criteria: age 18–40 years; at least 5 years of singles or doubles badminton experience; currently playing badminton 2–4 hours per week; ability to understand instructions in English; and clearance on the Exercise Preparticipation Health Screening Questionnaire for Exercise Professionals.
- Exclusion criteria: upper- or lower-limb injury within the preceding 6 months; musculoskeletal, neurological, visual, vestibular, cardiorespiratory or cognitive disorders; regular participation in sports

other than badminton; current use of analgesics, muscle relaxants or neuroleptic medication; pregnancy; or a positive response on Step 2 and any item in Step 3 of the screening questionnaire.

Sample size and analysed sample

The manuscript states that sample size estimation was performed in G*Power version 3.1 for a repeated-measures analysis involving two groups and three measurement points. A total of 66 participants were recruited. The final analysed sample comprised 32 participants, with 16 in the control group and 16 in the experimental group, after attrition and exclusion of one additional control participant to maintain equal final group sizes.

Recruitment, consent and group allocation

Participants who met the eligibility criteria provided written informed consent before participation. The manuscript indicates allocation to intervention or control groups, but the exact allocation method should be confirmed before registry submission.

Intervention: badminton-specific square-stepping exercise (bs-SSE)

The bs-SSE programme was delivered over 8 weeks on a 2.5 m × 1.0 m mat divided into 40 equal squares.

The programme used progressive forward, backward, lateral and diagonal stepping patterns designed to simulate badminton footwork demands.

Each session comprised a light-intensity warm-up (57 to <64% HRmax), a 30-minute moderate-intensity exercise phase (64 to <76% HRmax), and a very light-intensity cool-down (<57% HRmax).

The training content was adapted from the original square-stepping exercise approach. The manuscript reports excellent expert content validity for the bs-SSE protocol (I-CVI = 1.00; S-CVI/Ave = 1.00). Participants in the intervention group completed the bs-SSE programme five days per week, with each session lasting 30 minutes, for a total of eight weeks.

Comparator

The control group continued their usual daily and physical routines and did not receive the additional bs-SSE programme.

Outcome measures

Outcome domain	Instrument / metric	Time points
Dynamic balance	Y-Balance Test with anterior, posteromedial and posterolateral reaches	Baseline, week 4, week 8
Agility	Agility T-test; lower values indicate better performance	Baseline, week 4, week 8
Ankle strength	Handheld dynamometer measurement of bilateral dorsiflexor and plantar flexor strength (Newtons)	Baseline, week 4, week 8

Assessment schedule

Measure	Baseline	Week 4	Week 8
Eligibility screening and informed consent	Yes	No	No
Dynamic balance assessment	Yes	Yes	Yes
Agility assessment	Yes	Yes	Yes
Ankle strength assessment	Yes	Yes	Yes

Data handling and statistical analysis

Statistical analysis was conducted using IBM SPSS Statistics version 25.0.

Descriptive statistics summarised demographic and baseline characteristics, and normality was assessed before parametric testing.

Within-group changes across time were analysed using repeated-measures analysis of variance. Between-group differences at each time point were examined using independent-samples t-tests. Bonferroni adjustment was applied where appropriate. Statistical significance was defined as a two-tailed p value of less than 0.05.

Ethics, confidentiality and dissemination

The study received ethical approval under reference INTI-IU/FHLS-RC/BPHTI/7NY12022/020 and was reported as compliant with the Declaration of Helsinki (2013).

Participants provided written informed consent before enrolment. The manuscript does not describe confidentiality procedures in detail; these can be added if required by the intended registry.

The investigators stated that data are available upon reasonable request to the corresponding author. Findings from the completed study were prepared for manuscript publication and academic dissemination.

Completed-study statement for retrospective registration

This document was prepared after completion of recruitment, follow-up and statistical analysis. It is therefore a retrospective protocol reconstruction rather than a prospectively registered protocol.

The methods, intervention description, eligibility criteria, outcomes and analysis plan were derived from the revised manuscript and should be checked against original study records before registry submission.

End of protocol