A set of postural stabilization exercises to increase the physical fitness and functional state of student chess players

Complejo de ejercicios de estabilización postural para mejorar el nivel de preparación física y el estado funcional del organismo en estudiantes ajedrecistas

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Abstract

Introduction and Objective: The aim of the study was to evaluate the effectiveness of a 15-week training program for student chess players that utilized a set of postural stabilization exercises to improve their physical fitness, chess preparedness, and functional state.
Methods: The study involved 90 student chess players, who were divided into an experimental group and a control group of 45 people each. The experimental group trained according to the developed program, which included postural stabilization exercises, tasks on a balance cushion, coordination-strength exercises, Uzbek national active games, and special chess assignments; the control group continued with the traditional program.
Results: The content validity of the program was confirmed using Aiken's V: values for the 12 assessed aspects ranged from 0.81 to 0.94, with a mean of 0.89. Confirmatory factor analysis confirmed the three-factor structure of the assessment tool: physical fitness, chess preparedness, and functional state; the model fit indices were acceptable: $\chi2/df = 1.25$; CFI = 0.984; TLI = 0.975; RMSEA = 0.0527. The results of a mixed ANOVA revealed a statistically significant Time × Group interaction for physical fitness ($F = 30.6$; $p < 0.001$; $\eta2G = 0.085$), chess preparedness ($F = 37.0$; $p < 0.001$; $\eta2G = 0.090$), and functional state ($F = 30.1$; $p < 0.001$; $\eta2G = 0.082$). MANCOVA also confirmed the comprehensive effect of the program on the combination of the three gains (Pillai's Trace = 0.845; $F = 156.3$; $p < 0.001$).
Conclusions: The findings indicate that the developed program contributes to a significant improvement in the physical, chess, and functional preparedness of student chess players and can be recommended for implementation in the training process. $\eta2G = 0.082$). MANCOVA also confirmed the program's comprehensive effect across a combination of three increases (Pillai's Trace = 0.845; $F = 156.3$; $p < 0.001$).

Keywords

Student chess players; postural stability; physical training; chess training; functional state.

Resumen

Introducción y objetivo: El objetivo del estudio fue evaluar la eficacia de un programa de entrenamiento de 15 semanas para estudiantes ajedrecistas, basado en un conjunto de ejercicios de estabilización postural, con el fin de mejorar su condición física, preparación ajedrecística y estado funcional.
Métodos: En el estudio participaron 90 estudiantes ajedrecistas, distribuidos en un grupo experimental y un grupo de control, con 45 participantes en cada uno. El grupo experimental entrenó de acuerdo con el programa desarrollado, que incluía ejercicios de estabilización postural, tareas sobre cojín de equilibrio, ejercicios de coordinación y fuerza, juegos motores nacionales uzbekos y tareas especiales de ajedrez; el grupo de control continuó con el programa tradicional.
Resultados: La validez de contenido del programa fue confirmada mediante el método V de Aiken: los valores de los 12 aspectos evaluados oscilaron entre 0,81 y 0,94, con una media de 0,89. El análisis factorial confirmatorio confirmó la estructura trifactorial del instrumento de evaluación: condición física, preparación ajedrecística y estado funcional; los índices de ajuste del modelo fueron aceptables: $\chi^2/df = 1{,}25$; CFI = 0,984; TLI = 0,975; RMSEA = 0,0527. Los resultados del ANOVA mixto revelaron una interacción estadísticamente significativa Time × Group en la condición física ($F = 30{,}6$; $p < 0{,}001$; $\eta^2G = 0{,}085$), la preparación ajedrecística ($F = 37{,}0$; $p < 0{,}001$; $\eta^2G = 0{,}090$) y el estado funcional ($F = 30{,}1$; $p < 0{,}001$; $\eta^2G = 0{,}082$). El MANCOVA también confirmó el efecto integral del programa sobre la combinación de las tres ganancias evaluadas (Pillai's Trace = 0,845; $F = 156{,}3$; $p < 0{,}001$).
Conclusiones: Los resultados indican que el programa desarrollado contribuye a una mejora significativa de la preparación física, ajedrecística y funcional de los estudiantes ajedrecistas, por lo que puede recomendarse para su implementación en el proceso de entrenamiento.

Palabras clave

Estudiantes ajedrecistas; estabilización postural; preparación física; preparación ajedrecística; estado funcional.

Introduction

In recent years, the physical training of chess players has come to be regarded as an important component of their overall athletic preparation. This is because performance in chess depends not only on cognitive abilities but also on the capacity to maintain postural stability, functional endurance, concentration, and resistance to fatigue under conditions of prolonged intellectual strain. Although chess has traditionally been perceived primarily as an intellectual sport, modern research indicates that during training and competition, chess players experience measurable physiological and psychophysiological stress, which manifests as changes in cardiovascular, respiratory, and autonomic indicators (Semchenko et al., 2022; Fuentes-García et al., 2024). Concurrently, it has been proven that postural stabilization and neuromuscular training programs help improve balance, postural control, and functional readiness in physically active individuals (Marinković et al., 2024; López-Mesa et al., 2024). In this context, developing a set of postural stabilization exercises for student chess players can be considered a scientifically sound approach to enhancing their physical fitness and functional state within the framework of chess-oriented training and educational activities.

In the context of training student chess players, this problem is particularly relevant because chess involves prolonged static posture, high concentration, and a significant cognitive load. Insufficient general physical fitness and weak postural stabilization mechanisms can negatively affect the body's functional state, fatigue resistance, and the ability to maintain performance throughout a long game. Current World Health Organization recommendations emphasize the need for regular physical activity for children, adolescents, and adults, highlighting its importance for improving health, preventing the effects of a sedentary lifestyle, and maintaining the body's functional capabilities (Bull et al., 2020; WHO, 2020). Furthermore, recent studies show that exercises aimed at developing postural control, balance, and neuromuscular coordination help improve balance, functional stability, and motor efficiency in students and physically active young people (Wang et al., 2022; Mousa et al., 2024). Therefore, incorporating a set of postural stabilization exercises into the training regimen of student chess players can be seen as a promising way to enhance their physical fitness and functional state.

The university years are a significant period for forming stable mechanisms of physical performance, functional adaptation, and the prevention of consequences of a sedentary lifestyle. It is precisely during intensive academic activities that students often experience an increase in static load and a decrease in purposeful physical activity. For student chess players, this problem is particularly significant, as playing chess combines a prolonged sitting position, high concentration, emotional strain, and the need to maintain long-term intellectual productivity. Research on the physiological support of chess players shows that even with outwardly low physical activity, chess training is associated with changes in the functional indicators of the respiratory and cardiovascular systems, which confirms the need to consider the somatic and functional state of athletes in the training process (Semchenko et al., 2022; Vásquez-Orellana et al., 2022). Additionally, studies on the physical training of young chess players emphasize that physical culture can be used not only to strengthen the body but also to develop endurance, willpower, and psychophysical readiness for competitive activities (Maslyaev, 2022; Martynkova, 2024).

Postural stabilization exercises play a special role in solving this problem, as they are aimed at developing muscle control, balance, coordination, and body stability. For chess players, this has practical significance: maintaining a working posture at the chessboard for a long time is accompanied by static tension in the back, neck, and shoulder girdle muscles, which can increase fatigue and reduce overall functional comfort. Recent studies have shown that core stability training in students helps improve static and dynamic balance, flexibility, and the functional state of the musculoskeletal system (Yakut, 2021). Similar results have been obtained in sports practice: a 10-week core stability training program improved balance indicators in young basketball players compared to traditional strength training (Gong et al., 2024), and a systematic review of balance and core stability training confirmed the positive impact of such programs on postural control in various groups of trainees (Salar et al., 2023; Sáez-Michea et al., 2023).

The development of a set of postural stabilization exercises for student chess players has a scientific and practical basis, as chess activities require not only cognitive readiness but also the ability to maintain a stable working posture, functional endurance, and focus for an extended period. Modern research indicates that chess effectiveness is linked to the stability of game actions over time and the behavioral characteristics of players in long-term competitive practice (Chowdhary et al., 2023), while the psycho-physiological state of chess players can influence the quality of intellectual-sports tasks (Fuentes-García et al., 2024). However, it is important to consider that stabilization exercises alone do not ensure direct growth in chess mastery; their effect becomes methodologically significant when combined with special chess tasks for calculating variants, assessing position, and maintaining decision accuracy under conditions of fatigue.The development of a set of postural stabilization exercises for student chess players has a scientific and practical basis, as chess activities require not only cognitive readiness but also the ability to maintain a stable working posture, functional endurance, and focus for an extended period. Modern research indicates that chess effectiveness is linked to the stability of game actions over time and the behavioral characteristics of players in long-term competitive practice (Delfa-de-la-Morena et al., 2025), while the psycho-physiological state of chess players can influence the quality of intellectual-sports tasks (Fuentes-García et al., 2024). However, it is important to consider that stabilization exercises alone do not ensure direct growth in chess mastery; their effect becomes methodologically significant when combined with special chess tasks for calculating variants, assessing position, and maintaining decision accuracy under conditions of fatigue.

In this context, exercises on a balance cushion are of methodological interest because they combine moderate physical activity with the activation of balance, proprioception, and neuromuscular control mechanisms. Unlike intensive training methods, which can cause significant fatigue and interfere with subsequent intellectual work, stabilization exercises can be integrated directly into the structure of a chess lesson as short activity breaks or preparatory blocks. Research on core stabilization training shows that such exercises can improve static and dynamic balance, as well as enhance functional motor control (Panhale et al., 2024; Alecu et al., 2025). This makes them particularly suitable for the category of individuals for whom physical activity should support, rather than disrupt, cognitive performance.

The link between the body's functional state and cognitive load provides an additional basis for selecting postural stabilization methods. Studies on chess players note that during a chess game and complex problem-solving, indicators of heart rate variability and energy expenditure can change, reflecting the involvement of autonomic regulation mechanisms during intellectual strain (Rodoplu et al., 2022). Consequently, training methods aimed at improving body position regulation, breathing control, muscular stability, and post-exertion recovery can be considered an indirect resource for supporting the mental performance of chess players.

The practical significance of the proposed set of exercises also lies in the fact that exercises on a balance cushion do not require complex equipment, can be performed in a classroom or chess club, and are easily dosed by time, complexity, and the students' level of fitness. This allows them to be used both in the main part of a session and as short restorative and activating breaks between theoretical blocks, problem-solving, or training games. Such an approach aligns with the modern concept of functional training, where exercises are selected to account for the real conditions of an athlete's activity and are aimed at enhancing the body's ability to perform specific actions effectively (Plaza-Arancibia et al., 2024).

The further development of a postural stabilization exercise routine for student chess players should be based on the principle of applied focus: the exercises must be safe, brief, and easy to perform during a chess lesson, while also promoting the development of postural stability, coordination, muscle control, and the body's functional readiness. It is this logic that allows this routine to be seen not as an external supplement to chess training, but as an integral part of the educational and training process, aimed at enhancing the quality of chess players' preparation by optimizing their physical and functional condition.

It is important to recognize that for student chess players, physical training should be viewed not as a separate component detached from chess practice, but as a means of managing the athlete's performance state. In conventional sports training, movement is often aimed at developing strength, speed, or endurance. In chess, however, the ability to maintain an "economical" posture, sustained attention, and functional readiness without excessive fatigue is of paramount importance. Therefore, the most effective exercises are those that do not overload the body but instead activate stabilizer muscles, improve the sense of balance, and maintain neuromuscular readiness. Research on postural stability indicates that physical activity in an educational setting can be used to improve students' balance control and functional stability, which is particularly important for activities with a long static component (Yudho et al., 2025; Yu, T. et al., 2025).

The balancing cushion is of methodological interest for training student chess players, as exercises on an unstable support activate proprioceptive control, balance mechanisms, and posture microcorrection. Modern research indicates that balance and proprioception training contributes to improved postural stability and sensorimotor regulation, though such programs are primarily studied within the context of general physical training, rehabilitation, or motor sports (Yılmaz et al., 2024; Ketterer et al., 2024; Park et al., 2024).

The scientific shortcoming of this study is that the application of unstable support exercises in chess preparation remains insufficiently studied, especially in terms of their impact on maintaining working posture, reducing postural fatigue, and maintaining the quality of chess solutions. The originality of the study lies in integrating the balancing cushion and postural stabilization exercises directly into the chess-oriented training process, where physical-postural tasks are combined with variant calculations, position evaluation, and tactical tasks under conditions of prolonged intellectual load (Jang et al., 2025; Plaza et al., 2023).

The relevance of the proposed set of exercises is further underscored by the fact that modern chess increasingly demands high-intensity thinking under time constraints. Fast games, blitz, rapid, online tournaments, and training platforms create a situation where a chess player must not only know theory but also switch focus quickly, maintain concentration, control their emotional state, and preserve the accuracy of their moves. Studies of chess activity show that during a game, psychophysiological reactions related to stress, cognitive load, and changes in autonomic regulation are observed; therefore, the athlete's functional state becomes a significant component of performance (Fuentes-García et al., 2024).

A set of postural stabilization exercises for student chess players can be considered a pedagogically and physiologically grounded tool that combines physical education with the real requirements of chess activity. Its significance lies not only in developing balance and strengthening the body muscles but also in forming a more stable working state during the training process. The purpose of this study is to evaluate the effectiveness of a 15-week training program for student chess players using a set of postural stabilization exercises to enhance physical fitness levels, chess readiness, and the functional state of the body.

Method

The present study was organized as an experimental study with a pre-test/post-test control group design. The control and experimental groups were comprised of third-year students from the "Sports Activity (Chess) " program at the Uzbek State University of Physical Culture and Sports in Chirchik, Republic of Uzbekistan.

The experimental group included students who performed a specially developed set of postural stabilization exercises during the study period, aimed at improving their physical fitness and functional state. The control group students continued to follow the traditional training program without the inclusion of this additional set of postural stabilization exercises.

The inclusion criteria for the study were: enrollment in the third year of the "Sports Activity (Chess) " program, a satisfactory level of health, no health complaints, and clearance for physical exercise based on the results of a medical examination. Prior to the experiment, all participants underwent a medical examination by a staff doctor at the Uzbek State University of Physical Culture and Sports.

The experimental program lasted 15 weeks. During this period, a postural stabilization exercise regimen was integrated into the training process of the experimental group. This regimen included exercises for balance, muscle control, coordination, and postural stability, along with other exercises to enhance physical fitness. The program's effectiveness was evaluated through a comparative analysis of indicators obtained from the control and experimental groups before and after the experiment. This research design allowed for the determination of the proposed exercise regimen's impact on the physical fitness level and functional state of the student chess players.

Participants

The study involved student chess players engaged in an academic training program. After preliminary testing, participants were divided into experimental and control groups of 45 people, taking into account the comparability of age, chess qualifications, rating, training experience, and initial indicators of physical, functional, and chess fitness. This allowed for a reduction in the impact of initial intergroup differences and ensured a more accurate assessment of the effectiveness of the 15-week program. Chess readiness was evaluated based on three special indicators: the speed of calculating variants, the accuracy of position assessment, and tactical effectiveness. These indicators were chosen because they reflect the main components of a chess player's competitive activity: analysis speed, positional decision quality, and the ability to find tactical opportunities in game situations. Unlike the official rating, which reflects the overall competitive experience, these indicators allow for a more accurate assessment of the dynamics of chess performance under the conditions of the pedagogical experiment. The experimental group's training process incorporated a postural stabilization exercise regimen aimed at developing a stable working posture, coordination control, static muscular endurance, and the body's functional stability. The control group followed the traditional training program. Before the experiment, all participants' anthropometric, physical, chess-specific, and functional indicators were recorded to determine the subjects' baseline condition and ensure the groups were comparable.

The study sample comprised 90 student chess players with a mean age of 20.1 ± 1.2 years, who were divided into an experimental group and a control group of 45 people each. The groups were comparable in terms of key anthropometric and sports qualification indicators: the mean height of the participants was 172.4 ± 7.1 cm, body mass was 68.5 ± 8.7 kg, and body mass index was 23.0 ± 2.3 kg/m2. The mean chess experience was 8.4 ± 2.5 years, and the weekly training volume was 7.8 ± 2.1 hours. In terms of sports qualifications, the sample included students at the Second Sports Category and Candidate for Master of Sports levels, which allowed the participants to be considered a sufficiently skilled cohort for evaluating the effectiveness of a set of postural stabilization exercises within the training process.

Table 1. Descriptive Anthropometry

No.	Indicator	Total sample, n=90	Experimental group, n=45	Control group, n=45
1	Age, years	20.1 ± 1.2	20.0 ± 1.1	20.2 ± 1.3
2	Height, cm	172.4 ± 7.1	172.8 ± 6.9	172.0 ± 7.3
3	Body mass, kg	68.5 ± 8.7	68.9 ± 8.4	68.1 ± 9.0
4	Body mass index, kg/m2	23.0 ± 2.3	23.1 ± 2.2	22.9 ± 2.4
5	Chess experience, years	8.4 ± 2.5	8.5 ± 2.4	8.3 ± 2.6
6	Training volume, hours/week	7.8 ± 2.1	7.9 ± 2.0	7.7 ± 2.2
7	Sports qualification / rating	Second Sports Category — 30 (33.3%); First Sports Category — 36 (40.0%); Candidate Master of Sports — 24 (26.7%); rating 1845 ± 165	Second Sports Category — 15 (33.3%); First Sports Category — 18 (40.0%); Candidate Master of Sports — 12 (26.7%); rating 1852 ± 160	Second Sports Category — 15 (33.3%); First Sports Category — 18 (40.0%); Candidate Master of Sports — 12 (26.7%); rating 1838 ± 170

This study was officially approved by the university, and the relevant permission was presented to the students' parents. In addition, written parental consent was obtained for each student's participation in the research.

Procedure

The training program for student chess players is designed not as a separate block of general physical training, but as specially organized support for their educational and training process. The main emphasis is placed on developing postural stability, coordination, static endurance of core muscles, reaction speed, and the ability to maintain performance under prolonged intellectual strain. Therefore, the microcycles include not only bodyweight and resistance band exercises, but also extended tasks on a balance cushion, ball exercises, elements of dynamic balance, and traditional Uzbek active games that develop agility, strength, attention, speed of movement, and teamwork. This combination of methods makes the physical training of student chess players more varied, emotionally engaging, and functionally linked to the demands of playing chess.

The 15-week program was structured around the principle of a gradual increase in training load, followed by specialization. Each week corresponded to one microcycle. The load distribution within the microcycle took into account the students' academic schedule: the subjects attended mandatory classes at the university in the morning, so optional training sessions were held in the afternoon and lasted 80 minutes. The structure of each session included a preparatory part—a warm-up, breathing and mobility exercises, and preparing the musculoskeletal system for the load; the main part—performing postural stabilization exercises, tasks on a balance cushion, coordination and strength exercises, and chess tasks focused on calculating variations, positional evaluation, and tactical performance; and a final part—recovery exercises, stretching, breath regulation, and a brief analysis of the work completed. In volume-building, regular, and shock microcycles, the load gradually increased from Monday to midweek, peaking on Wednesday and decreasing by Friday. In contrast, special-preparatory microcycles used a two-peak structure, with increased loads on Tuesday and Thursday. Saturday sessions were restorative and unloading in nature, featuring sports games like volleyball, basketball, badminton, and football. These were used as a means of active recovery, emotional release, and developing coordination, reaction speed, general motor activity, and teamwork among the student chess players.

Table 2. Training Program for Student Chess Players

Week	Microcycle Type and Load	Microcycle Goal	Physical Exercises and National Movement Games	Chess Assignments
1	Volumetric-absorbing microcycle. Single-peak structure, peak in the middle of the week. Load: 60–65%	Adaptation to the program	Joint warm-up; breathing exercises; walking with a change of direction; standing on one leg; light squats; cat-camel stretch; glute bridge; balance cushion 3×1 min; "Oq terakmi, ko'k terak" game for reaction time and teamwork	Initial assessment: 10 tactical puzzles, 5 positions for evaluation, 5 puzzles for calculation of variations; recording the baseline level
2	Volumetric-absorbing microcycle. Single-peak load increase. Load: 65–70%	Mastering postural control	Plank 2×25–30 sec; side plank on knees; exercises on the balance cushion: standing, half-squat, weight transfer; walking along a line; coordination exercises with a ball; "Qirq tosh" game for agility and speed of movement	12–15 tactical puzzles; calculation of variations 2–3 moves deep; 6 positions for evaluation; short game 10+5 with analysis
3	Volumetric-absorbing microcycle. Peak in the middle of the week, decreasing toward the end. Load: 70–75%	Technique reinforcement	Plank 3×30 sec; reverse lunges; bird-dog; balance cushion 4×1 min with eyes closed for 5–10 sec; throwing and catching a ball while standing on the cushion; "Chillak" game in an adapted form for coordination and visual estimation	15 tactical puzzles; 8 positions for evaluation; time-limited calculation puzzles; game 15+10
4	Ordinary training microcycle. Increase in volume and intensity up to +40%	Developing a stable working posture	Circuit training: plank, squats, lunges, resistance band pulls, balance cushion 5×1 min; shoulder girdle stabilization exercises; "Arqon tortish" game for strength, team coordination, and stability	18–20 tactical puzzles; 8–10 positions for evaluation; 10 speed calculation tasks; analysis of one game
5	Ordinary training microcycle. Load +40%	Developing balance and coordination	Balance cushion: one-leg stand, half-squat, torso twists, work with a ball; line jumps; shuttle runs; plank 3×40 sec; "Kim chaqqon?" game for reaction speed	20 tactical puzzles; 10 positions for evaluation; calculation of forced variations; 2 games 10+5
6	Ordinary training microcycle. Single-peak structure. Load +40%	Improving attention span	Dynamic warm-up; exercises with a resistance band; dead bug; bird-dog; side plank; balance cushion 6×1 min; maintaining correct posture at the board for 20–25 min; "Oq suyak" game for orientation and quick search	Solving puzzles immediately after the physical block; 20–25 tactical puzzles; 10 positions for evaluation; building a variation tree
7	Ordinary training microcycle. Load +40%, decreasing by the end of the week	Intermediate form stabilization	Combined workout: plank, side lunges, squats with a pause, balance cushion for 8–10 min total; neck and shoulder relaxation exercises; "Qirq tosh" game for coordination and agility	Assessment block: 10 speed problems, 10 tactical problems, 6 positions for evaluation; error analysis
8	High-intensity microcycle. Increase in volume and intensity up to +70%	Development of postural endurance	Circuit 3–4 times: 45-sec plank, side plank, lunges, side jumps, weight transfers on a balance cushion; extended work on the cushion for 10–12 min total; "Arqon tortish" game for strength stability	25–30 tactical problems; calculating variations under time pressure; 2 games of 15+10; analysis of decisions made under fatigue
9	High-intensity microcycle. Load +70%	Fatigue resistance	Balance cushion: standing with head turns, half-squats, catching a ball, working with eyes closed; holding a working posture for 30 min; interval movements; "Oq terakmi, ko'k terak" game for reaction and team endurance	A series of problems before and after a 35–40 min workout; 30 tactical problems; 10 positions for evaluation; one 10+5 game
10	High-intensity microcycle. Peaking mid-week, decreasing toward the end. Load +70%	Maintaining quality of thought under load	Functional circuit: step-ups, lunges, squats, plank, ball exercises, balance cushion for 12 min; breathing recovery; "Chillak" game in an adapted format for coordination, reaction speed, and precision	30 tactical problems; 12 positions for evaluation; calculation of complex variations; a 25+10 game with written analysis
11	High-intensity microcycle. Load +70%	Monitoring load tolerance	Plank until technical failure; side plank; jumps over markings; balance cushion for a total of 12–15 min; core stabilization exercises in a sitting position; "Kim chaqqon?" game for speed and attention	Intermediate assessment: 20 tactical problems, 10 calculation problems, 8 positions for evaluation; before/after

				comparison following a 45-minute workload
12	Special preparatory. Two-peak structure: peak 1 and peak 2 mid-week. Load up to +90%	Integration of physical and chess fitness	Peak 1: core strength stabilization, plank, lunges, work with resistance bands. Peak 2: balance cushion for 15 min, stances, turns, catching a ball, half-squats. "Arqon tortish" game as a strength-based team block	Peak 1: problems on calculation speed. Peak 2: a 25+10 model game. After the physical block — a tactical series for decision-making stability
13	Special preparatory. Two-peak load increase. Load +90%	Simulating competition load	Maintaining a working posture for 35–40 min; balance cushion for a total of 15–18 min; exercises for the core, shoulder girdle, and pelvis; "Qirq tosh" game for agility and changing direction	2 model games; 30 tactical problems; 12 positions for evaluation; written analysis of critical moments
14	Special preparatory. Two peaks, tapering toward the end of the week. Load +90%	Pre-assessment readiness	Balance cushion: prolonged standing, ball exercises, torso rotations, eyes-closed exercises; plank (3–4 sets); active game "Oq suyak" for orientation, attention, and reaction speed; recovery exercises	Pre-control: 20 speed exercises, 20 tactical exercises, 10 positions for evaluation; 30+10 game; attention stability analysis
15	Tapering microcycle. Targeted load reaching up to 100%, followed by a reduction toward the end of the week	Final readiness check	At the beginning of the week - a supportive complex; in the middle - control tests FP1–FP3; balancing cushion for 10-12 minutes without fatigue; light national games "Kim chaqqon?" and "Oq terakmi, kök terak" in a restorative mode.	Final testing of CP1–CP3 and FS3; a series of exercises before/after a 45-minute load; control game; final analysis of the dynamics

Nota: FP1 — Postural Stability; FP2 — Dynamic Coordination Stability; FP3 — Static Core Endurance; CP1 — Calculation Speed; CP2 — Positional Evaluation Accuracy; CP3 — Tactical Performance; FS1 — Functional Response to Load; FS2 — Recovery Rate; FS3 — Resistance to Mental and Postural Fatigue.

Measurement

Data was collected to comprehensively assess the impact of a postural stabilization exercise program on the physical fitness, chess performance, and functional state of student chess players. All measurements were taken in two stages: before the start of the pedagogical experiment and after the completion of the experimental cycle. This approach allowed for determining the participants' baseline fitness level and subsequently evaluating the dynamics of changes in the experimental and control groups (Zemková, 2022; Rodríguez-Perea et al., 2023).

Before testing, students were briefed on the purpose, task procedures, and safety rules. The measurements were conducted under standardized conditions to ensure objectivity and reduce the influence of random factors on the research results.

First, physical fitness indicators related to postural stability were recorded: the ability to maintain balance, coordinative stability, and static core muscle endurance. For this, the modified Romberg test, the Y-Balance Test, and the plank test were used. These methods made it possible to determine a student's ability to control body position, maintain a stable working posture, and sustain core muscle activity over a specific period (Foldager et al., 2023).

The second stage assessed the students' level of chess proficiency. This was done using standardized chess tasks: a test of calculation speed, a positional evaluation subsequently compared with a Stockfish benchmark analysis, and a series of tactical puzzles (Gonzalez-Burgos et al., 2024). During these tasks, the time taken to solve, the number of correct answers, and the quality of the selected moves were recorded. This allowed for an assessment of not only the extent of chess knowledge but also the stability of cognitive performance. The functional state of the body was determined using indicators of reaction to a standard workload and subsequent recovery. Specifically, the Ruffier–Dickson test, an assessment of heart rate recovery after a step test, and a comparison of chess performance before and after a 45-minute training session were used (Pooni et al., 2025; Reyes-Ferrada et al., 2021).

The results obtained were recorded in individual examination protocols and then converted to a unified assessment scale. For indicators where a higher value reflected a better result—such as balance hold time, reaching distance in the Y-Balance Test, and the number of correct chess solutions—a direct scale was used. For indicators where a lower value signified a better result—such as problem-solving time or the Ruffier–Dickson index—reverse scaling was applied. A unified interpretation of all indicators was maintained: the higher the final score, the higher the student's level of preparedness.

Data analysis

The data were analyzed using descriptive and inferential statistics with JAMOVI software version 2.7.2 (Navarro & Foxcroft, 2022; JAMOVI, 2024) to test the significance and impact of the intervention on the postural stability of study participants. JAMOVI was selected for statistical analysis due to its userfriendly interface, efficiency, and reliability. Its structured workflow allowed for precise data processing and analysis.

SPSS software version 24 (IBM Corp., IBM SPSS Statistics for Windows) was also used for statistical calculations in this study. Aiken's V formula was used to test the validity of the instrument. The preliminary analysis included a visual inspection of the normality of the standardized residuals' distribution using a Q-Q plot, as well as a test for homogeneity of variances between groups using Levene's test.

To test the hypotheses, a 2 x 2 factorial multivariate analysis of variance (MANOVA) was used, involving two groups (experimental group and control group) and two measurement time points (pre-test and post-test after 15 weeks of intervention).

Results

To verify the content validity of the developed training program for student chess players, which incorporates a set of postural stabilization exercises, an expert assessment was conducted using Aiken's V coefficient. The expert panel comprised 8 specialists: 4 experts in physical education holding a Doctor of Science degree, and 4 experts in chess training—coaches and International Masters with over 15 years of professional experience. The experts evaluated the program content's alignment with the research objectives, the methodological soundness of the training load distribution, the appropriateness of including postural stabilization exercises, the program's applicability within the educational and training process at the Uzbek State University of Physical Culture and Sports, and the suitability of the chess tasks for developing calculation of variations, positional assessment accuracy, and tactical performance. The evaluation was conducted on a 5-point scale, and a program item was considered valid if Aiken's V coefficient was 0.80 or higher, indicating a sufficient degree of expert consensus and content validity of the included components.

Table 3. Validation of the Training Program for Student Chess Players Using a Set of Postural Stabilization Exercises

No.	Assessed Aspect	Σs	V	Description
1	Suitability of the program for the objectives of the educational and training process of student chess players at the Uzbek State University of Physical Culture and Sport	28	0.88	Accepted
2	Correspondence of the program content with the development of postural stability, coordination, and static core endurance	27	0.84	Accepted
3	The scientific rationale for including postural stabilization exercises in the training of student chess players	29	0.91	Accepted
4	The suitability of the physical exercises for the students' age, fitness level, and academic schedule	29	0.91	Accepted
5	The adequacy and logical sequence of the 15-week training program's structure	27	0.84	Accepted
6	The methodological validity of load distribution across introductory, standard, shock, special-preparatory, and tapering microcycles	27	0.84	Accepted
7	The rational combination of physical exercises, balance cushion exercises, and recovery-oriented methods	26	0.81	Accepted
8	The appropriateness of using Uzbek national active games to develop agility, reaction speed, coordination, and teamwork	29	0.91	Accepted
9	Correspondence of chess tasks with the development of calculation speed, positional evaluation accuracy, and tactical performance	29	0.91	Accepted
10	The validity of combining physical-postural load with chess tasks under conditions of mental and postural fatigue	29	0.91	Accepted
11	The practical applicability of the program during optional afternoon training sessions without disrupting the primary educational process	30	0.94	Accepted
12	The possibility of objectively evaluating program effectiveness through indicators of physical preparation, chess preparation, and functional state	30	0.94	Accepted
	Average	28.33	0.89	Accepted

Table 3 shows that all 12 aspects of the program received Aiken's V values from 0.81 to 0.94, which exceeds the minimum validity threshold of V ≥ 0.80 and confirms their acceptability. The average value of V = 0.89 indicates high expert agreement and content validity of the developed program.

To confirm that the developed assessment tool indeed measures the intended constructs for student chess player preparation, a Confirmatory Factor Analysis (CFA) was conducted. The analysis was based on three theoretically substantiated latent factors: F1—level of physical preparation related to postural stability, F2—level of chess preparation, and F3—level of the body's functional state. These constructs were formed based on the research objective, the content of the training program for student chess players using a set of postural stabilization exercises, and the results of a preliminary expert validation.

Table 4. Validation of the Assessment Instrument for the Training Program of Student Chess Players

Latent factor	Item Code	Standardized Loading	Description
Physical Preparation	FP1	0.956	Accepted
	FP2	0.703	Accepted
	FP3	0.778	Accepted
Chess Preparation	CP1	0.716	Accepted
	CP2	0.825	Accepted
	CP3	0.915	Accepted
Functional State	FS1	0.800	Accepted
	FS2	0.845	Accepted
	FS3	0.665	Accepted

Model Fit Summary: $\chi2/df = 1.25$ | CFI = 0.984 | TLI = 0.975 | RMSEA = 0.0527 | 90% CI RMSEA = 0.000–0.86

Table 4 shows that the results of the confirmatory factor analysis indicated a good fit of the three-factor model to the empirical data: $\chi2 = 30.0$; df = 24; $p = 0.185$; $\chi2/df = 1.25$; CFI = 0.984; TLI = 0.975; RMSEA = 0.0527(χ^2 is the chi-square statistic, which reflects the degree of discrepancy between the theoretical model and the empirical data; df refers to the degrees of freedom; p indicates the level of statistical significance; χ^2/df is the relative chi-square index of model fit; CFI and TLI are comparative model fit indices; and RMSEA is the root mean square error of approximation.). All standardized factor loadings exceeded the acceptable level, which confirms the validity of the FP1–FP3, CP1–CP3, and FS1–FS3 indicators for assessing the physical fitness, chess proficiency, and functional state of student chess players.

Statistically significant positive correlations were found between the latent factors: F1–F2 = 0.327; $p = 0.004$, F1–F3 = 0.281; $p = 0.014$, F2–F3 = 0.334; $p = 0.003$, which indicates the interconnectedness of the students' physical, chess, and functional preparedness.

Figure 1. Path diagram

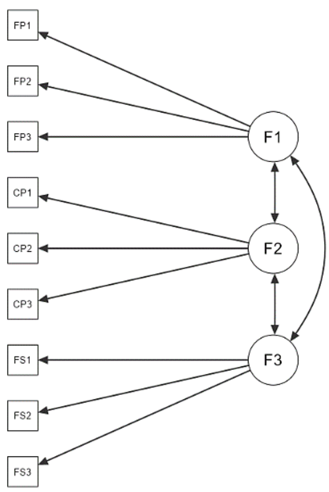


Figure 1 shows the path diagram reflects the study's three-factor measurement model, in which the indicators FP1–FP3 characterize the level of physical fitness, CP1–CP3 characterize the level of chess proficiency, and FS1–FS3 characterize the functional state of student chess players. The covariances between F1, F2, and F3 show the interconnectedness of these components of preparedness.

To prove the effectiveness of the pedagogical experiment, integral indicators were calculated for each latent factor after the structure of the measurement model was confirmed. This approach was methodologically justified because the indicators within each factor reflected a single content component: FP1–

FP3 characterized physical fitness related to postural stability, CP1–CP3 characterized chess proficiency, and FS1–FS3 characterized the functional state of the body. Since all indicators were converted to a single 10-point scale and had the same direction of interpretation, averaging them made it possible to obtain generalized Physical, Chess, and Functional indicators before and after the experiment.

A preliminary confirmatory factor analysis confirmed the three-factor structure of the model and showed acceptable standardized factor loadings for the indicators, which served as the basis for combining individual indicators into integral variables. Next, based on these integral indicators, the dynamics of changes in the experimental and control groups were assessed before and after the implementation of the training program for student chess players, which used a set of postural stabilization exercises. The assessment was performed using a repeated measures ANOVA.

Table 5. Mixed ANOVA for the Physical Fitness Factor

	Sum of Squares	df	Mean Square	F	p	$\eta 2_G$
Time	15.17	1	15.173	47.5	<.001	0.126
Time ✻ Group	9.76	1	9.763	30.6	<.001	0.085
Group	9.71	1	9.707	11.0	.001	0.084

According to Cohen (1988), effect sizes are interpreted as small ($\eta 2 = 0.01$), medium ($\eta 2 = 0.06$), and large ($\eta 2 = 0.14$).

Based on Table 5, the main effect of Time shows that physical fitness scores changed overall from the beginning to the end of the experiment, regardless of the group. Since $p < .001$, the changes are statistically significant. The value $\eta 2G = 0.126$ indicates a strong, nearly large effect of time. The Time × Group interaction shows that the dynamics of change differed between the experimental and control groups. Since $p < .001$, it can be concluded that after 15 weeks, the experimental group improved significantly more than the control group. The value $\eta 2G = 0.085$ corresponds to a medium effect size.

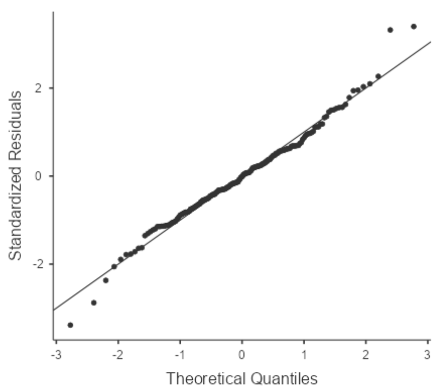
Table 6. Homogeneity of Variances Test (Levene's)

	F	df1	df2	p
Physical_Pre	0.111	1	88	.740
Physical_Post	0.498	1	88	.482

Physical_Pre — students' physical fitness score before the experiment; Physical_Post — students' physical fitness score after the implementation of the postural stabilization program.

Based on Table 6, both p-values are > 0.05, which means the assumption of homogeneity of variances is not violated. The groups can be compared.

Figure 2. Q-Q plot



A repeated measures ANOVA revealed a statistically significant main effect of time ($F = 47.5$; $p < 0.001$; $\eta 2G = 0.126$) and a significant Time × Group interaction ($F = 30.6$; $p < 0.001$; $\eta 2G = 0.085$). This indicates that after the 15-week program, the physical fitness of the students in the experimental group improved significantly more than that of the control group, with the effect size being moderate and practically significant. η2G = 0.085).

Next, the dynamics of changes in chess performance in the experimental and control groups were assessed using integral indicators before and after the implementation of the training program for student chess players, which incorporated a set of postural stabilization exercises.

Table 7. Mixed ANOVA for the chess performance factor

	Sum of Squares	df	Mean Square	F	p	$\eta 2_G$
Time	28.6	1	28.624	88.7	<.001	0.192
Time × Group	11.9	1	11.940	37.0	<.001	0.090
Group	12.5	1	12.52	12.0	<.001	0.094

Table 7 presents the results of a Mixed ANOVA for the "chess proficiency" factor, which assessed changes in performance before and after the experiment in the control and experimental groups. The data revealed a statistically significant main effect of time ($F = 88.7$; $p < .001$; η2G = 0.192), indicating an overall improvement in chess proficiency after the 15-week period. There was also a significant Time × Group interaction ($F = 37.0$; $p < .001$; η2G = 0.090), confirming that the improvement in the experimental group was greater than in the control group. The main effect of group was also significant ($F = 12.0$; $p < .001$; η2G = 0.094), indicating the presence of between-group differences; however, the primary evidence for the program's effectiveness is the Time × Group interaction. The group effect was also significant (F = 12.0; $p < .001$;

Table 8. Test of Homogeneity of Variances (Levene's)

	F	df1	df2	p
Chess_Pre	0.327	1	88	.569
Chess_Post	0.514	1	88	.475

According to Table 8, the results of Levene's test for homogeneity of variances between the experimental and control groups on chess proficiency measures (before and after the experiment) are favorable. The obtained p-values of 0.569 for Chess_Pre and 0.475 for Chess_Post exceed the significance level of 0.05. Therefore, the differences in variances between the groups are not statistically significant, and the assumption of homogeneity of variances is met. This confirms that using Mixed ANOVA to analyze this variable was appropriate.

Figure 3. Q-Q Plot

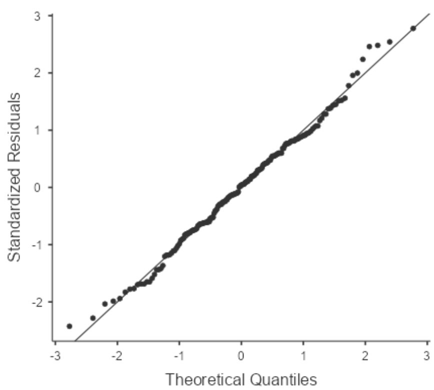


Figure 3 presents the Q-Q plot shows that the residuals are generally located close to the diagonal line; therefore, no serious visual violations of normality are observed. The results indicate that after the 15-week pedagogical experiment, the increase in chess preparedness in the experimental group was statistically significantly higher than in the control group.

Next, using integral indicators, the dynamics of changes in the functional state of the subjects in the experimental and control groups were assessed before and after implementing a training program for student chess players that used a set of postural stabilization exercises.

Table 9. Mixed ANOVA for the functional state factor

	Sum of Squares	df	Mean Square	F	p	$\eta 2_G$
Time	18.91	1	18.909	58.5	<.001	0.147
Time ✻ Group	9.73	1	9.735	30.1	<.001	0.082
Group	10.2	1	10.234	11.1	.001	0.085

Based on the results of the Mixed ANOVA in Table 9 for the "functional state" factor, which compared indicators before and after the experiment in the control and experimental groups, the data revealed a statistically significant main effect of time ($F = 58.5$; $p < .001$; $\eta 2G = 0.147$). This indicates a general improvement in the students' functional state after the 15-week program. A significant Time × Group interaction ($F = 30.1$; $p < .001$; $\eta 2G = 0.082$) indicates that the increase in scores was greater in the experimental group than in the control group, meaning the implemented program had a positive impact on the functional state of the student chess players. The main effect of group was also significant ($F = 11.1$; $p = .001$; $\eta 2G = 0.085$), confirming the presence of between-group differences. $\eta 2G = 0.082$) indicates that the increase in indicators in the experimental group was higher than in the control group, meaning the implemented program had a positive impact on the functional state of the student chess players. The group effect was also significant ($F = 11.1$; $p = .001$;

Table 10. Homogeneity of Variances Test (Levene's)

	F	df1	df2	p
Functional_Pre	0.320	1	88	.573
Functional_Post	0.673	1	88	.414

Based on Table 10, the results of Levene's test for homogeneity of variances between the experimental and control groups on the "functional state" factor before and after the experiment were not significant. The obtained p-values of $p = .573$ for Functional_Pre and $p = .414$ for Functional_Post exceed the significance level of .05; therefore, no statistically significant differences in variance were found between the groups.

An analysis of the latent factor "functional state" showed that after the 15-week program, the experimental group exhibited a more pronounced positive trend compared to the control group. This indicates the effectiveness of the postural stabilization exercise program in improving the functional stability of student chess players. The results suggest that the program promotes better adaptation of the body to stress, accelerates recovery, and helps maintain performance under conditions of mental and postural fatigue.

Figure 4. Q-Q Plot

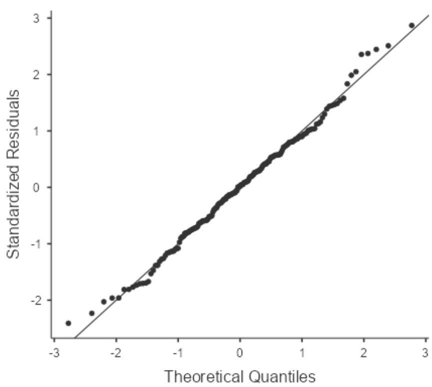


Figure 4 shows a Q-Q plot of standardized residuals, used for a visual check of the normality assumption for the analysis. The points are located mainly along the diagonal line, which indicates that the distribution of residuals is close to normal. Minor deviations are observed only at the extremes of the plot and are not significant. Therefore, the assumption of a normal distribution of residuals can be considered acceptable, which validates the use of repeated measures analysis of variance.

Table 11. MANCOVA Multivariate Tests

		Value	F	df1	df2	p
Group	Pillai's Trace	0.845	156.3	3	86	<.001
	Wilks' Lambda	0.155	156.3	3	86	<.001
	Hotelling's Trace	5.452	156.3	3	86	<.001
	Roy's Largest Root	5.452	156.3	3	86	<.001

Table 11 shows the results of the MANCOVA multivariate analysis, which assessed the overall effect of group membership on the combined gain in three indicators: physical fitness, chess skill, and functional state. The Pillai's Trace value = 0.845; F = 156.3; p < .001 indicates a statistically significant and pronounced overall difference between the experimental and control groups, meaning the implemented program had a substantial effect on the combined dynamics of the studied indicators.

Table 12. MANCOVA Univariate Tests

	Dependent Variable	Sum of Squares	df	Mean Square	F	p
Group	Physical_Gain	10.8	1	10.800	17.9	<.001
	Chess_Gain	13.6	1	13.600	22.1	<.001
	Functional_Gain	9.4	1	9.400	15.2	<.001
Residuals	Physical_Gain	53.1	88	0.603		
	Chess_Gain	54.1	88	0.615		
	Functional_Gain	54.4	88	0.618		

Table 12 presents the results of the univariate tests for each dependent variable. Statistically significant differences between the groups were found for all three gains: Physical_Gain, Chess_Gain, and Functional_Gain (*p* < .001), confirming that the experimental group demonstrated a more pronounced improvement in physical fitness, chess skill, and functional state compared to the control group.

Discussion

This study evaluated the effectiveness of a 15-week training program for student chess players. The program was based on a combination of chess problems, postural stabilization exercises, work on a balance cushion, coordination and strength exercises, and recreational recovery activities. The experiment involved 90 student chess players divided into an experimental and a control group of 45 people each. Before the experiment, the groups had similar baseline indicators, which allowed for a correct assessment of the dynamics of change after the program's implementation.

The first stage involved an expert validation of the program's content using Aiken's V coefficient. All 12 evaluated aspects of the program exceeded the minimum acceptable level of content validity (V ≥ 0.80), with values ranging from 0.81 to 0.94 and an average score of V = 0.89. This indicates a high consistency among expert assessments and confirms that the program's structure, load distribution, and the content of its exercises and chess problems are methodologically sound.

Next, the study's measurement model was tested using confirmatory factor analysis (CFA). The CFA confirmed the three-factor structure of the assessment instrument, which includes physical fitness, chess proficiency, and functional state of the body. The model fit indices were acceptable: $\chi 2$ = 30.0; df = 24; p = 0.185; $\chi 2$/df = 1.25; CFI = 0.984; TLI = 0.975; RMSEA = 0.0527, which indicates a good fit between the theoretical model and the empirical data.

The standardized factor loadings also confirmed the suitability of the selected indicators. For the physical fitness factor, the values were 0.956, 0.703, and 0.778; for the chess proficiency factor, 0.716, 0.825, and 0.915; and for the functional state factor, 0.800, 0.845, and 0.665. Consequently, each of the nine indicators made a meaningful contribution to the measurement of its corresponding latent factor, and the model itself can be considered statistically and methodologically sound. 0.778, for the chess preparation factor - 0.716; 0.825; 0.915, for functional status - 0.800; 0.845; 0.665.

A preliminary check of assumptions showed that the conditions for applying analysis of variance were generally met. Levene's test for the chess training level indicator yielded p-values of 0.569 for Chess_Pre and 0.475 for Chess_Post, and for the functional state indicator, p-values of 0.573 for Functional_Pre and 0.414 for Functional_Post, which indicates homogeneity of variances between groups. The Q-Q plots of standardized residuals primarily showed points distributed along the diagonal line, which allows the distribution of residuals to be considered acceptable for further analysis.

The Mixed ANOVA results for the physical fitness factor showed a statistically significant effect of time: $F = 47.5$; $p < 0.001$; $\eta 2G = 0.126$, reflecting an overall improvement in the indicators after the 15-week period. The most important result was a significant Time × Group interaction: $F = 30.6$; $p < 0.001$; $\eta 2G = 0.085$. This means that the increase in physical fitness in the experimental group was greater than in the control group, and the program itself had a practically significant impact on the development of postural stability, coordination, and static core endurance.

A pronounced positive trend was also observed for the chess proficiency factor. The time effect was $F = 88.7$; $p < 0.001$; $\eta 2G = 0.192$, and the Time × Group interaction was $F = 37.0$; $p < 0.001$; $\eta 2G = 0.090$. These data indicate that the experimental group demonstrated a more significant increase in the speed of calculating variations, the accuracy of positional assessment, and tactical performance, which confirms the link between physical-postural stability and the quality of chess task execution.

Similar results were obtained for the functional state factor: the time effect was $F = 58.5$; $p < 0.001$; $\eta 2G = 0.147$, and the Time × Group interaction was $F = 30.1$; $p < 0.001$; $\eta 2G = 0.082$. This suggests that the students in the experimental group adapted better to the workload, recovered faster, and maintained their performance more consistently under conditions of mental and postural fatigue. This result is particularly important for chess training, as a long game requires not only cognitive readiness but also a stable functional state.

A MANCOVA multivariate analysis confirmed the overall systemic effect of the program. A Pillai's Trace value of 0.845 with $F = 156.3$, $df1 = 3$, $df2 = 86$, $p < 0.001$ showed that the experimental and control groups differed statistically significantly in the combined gains across three indicators: Physical_Gain, Chess_Gain, and Functional_Gain. Univariate tests also confirmed significant differences for each indicator separately: Physical_Gain ($F = 17.9$, $p < 0.001$), Chess_Gain ($F = 22.1$, $p < 0.001$), and Functional_Gain ($F = 15.2$, $p < 0.001$).

The results obtained should be interpreted not as direct evidence that postural/core stability exercises alone enhance chess mastery, but as confirmation of their indirect impact on the conditions in which chess activities are implemented. Modern data show that training on unstable support and core training do indeed improve balance and postural stability, but their impact on athletic performance is not the same: some studies note pronounced improvements in balance and functional stability, while the increase in speed and certain specific indicators may be limited or statistically insignificant (Gao et al., 2025; Yu et al., 2025). This allows us to view the identified changes in student chess players not as a simple "transfer" of physical preparation to a chess result, but as the result of forming a more stable physical and functional foundation for long-term intellectual activity.

The theoretical significance of the study lies in the fact that chess players' training is examined through the prism of the interaction between postural control, functional stability, and cognitive performance. Literature emphasizes that the relationship between core strength, core stability, and athletic performance remains ambiguous and is likely to be indirect rather than direct (Schulte et al., 2025). For chess players, this is especially important, as during the game, cognitive load is combined with a prolonged static body position. Dual-task studies show that performing cognitive tasks can change the parameters of postural control, especially when support conditions become more complex or attention requirements increase (Saraiva et al., 2024).

The developed program contributed to a reduction in postural discomfort, more economical maintenance of working posture, and better regulation of fatigue, which created favorable conditions for calculating options, assessing positions, and making tactical decisions. This aligns with data indicating that chess activities are accompanied by pronounced cognitive and psychophysiological stress, and that autonomic regulation indicators can be used to assess the stress and functional state of chess players (Fuentes-García et al., 2024). At the same time, the use of recovery indicators after exertion requires careful interpretation: heart rate recovery reflects the body's overall functional adaptation but is not a direct indicator of chess mastery. Therefore, the main theoretical conclusion of the study is that postural-stabilization training can be significant not in itself, but as a component of a comprehensive chess-oriented program that supports the physical stability, functional recovery, and cognitive efficiency of student chess players.

The findings have practical significance for improving the training process of student chess players, as they confirm that a 15-week program incorporating postural stabilization exercises leads to comprehensive improvements in physical fitness, chess preparedness, and the functional state of the body. The implementation of exercises for postural control, a balance cushion, static core endurance, coordination-strength tasks, and national active games helped increase the stability of the playing posture, reduce signs of postural fatigue, and create more favorable conditions for performing chess tasks related to calculating variations, assessing the position, and achieving tactical effectiveness. The significant results from the Mixed ANOVA and MANCOVA analyses indicate that the positive changes in the experimental group were systemic rather than random, which is consistent with modern concepts regarding the influence of core stability and postural training on balance, functional stability, and athletic performance (Rodríguez-Perea et al., 2023; Zemková, 2022; Zulhasniati et al., 2024). However, the study has certain limitations: the program was tested on a sample of students from a single university, and the pedagogical experiment lasted 15 weeks. Therefore, it is advisable to expand the sample in future research to include students with varying levels of chess proficiency and to conduct follow-up testing to assess the long-term stability of the observed effect.

Conclusions

The results showed that a 15-week training program for student chess players, which incorporated a set of postural stabilization exercises, had a positive impact on their physical fitness, chess preparedness, and functional state. Expert validation confirmed the content validity of the program: all 12 evaluated aspects received Aiken's V values above the acceptable threshold, ranging from 0.81 to 0.94, with a mean value of V = 0.89. Confirmatory factor analysis also supported the three-factor structure of the assessment tool, which includes physical fitness, chess preparedness, and functional state, demonstrating a good model fit to the empirical data.

The results of the Mixed ANOVA revealed that upon completion of the experiment, students in the experimental group showed more pronounced positive changes compared to the control group. Significant Time × Group interactions were identified across all three areas: physical fitness, chess preparedness, and functional state. This indicates that the implemented program not only improved postural stability, coordination, and static core endurance but also positively affected the speed of calculating variations, the accuracy of positional assessment, tactical performance, and resistance to mental and postural fatigue.

Thus, the developed program can be considered an effective means of comprehensive training for student chess players within the educational and training process. Its practical value lies in the fact that postural stabilization exercises, tasks on a balance cushion, coordination and strength exercises, national active games, and special chess assignments form an integrated system aimed at improving physical, functional, and intellectual performance. It would be beneficial in the future to expand the research sample to include chess players of various skill levels and to conduct delayed testing to assess the stability of the observed effect.

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Conflict of Interest

The authors declare no conflict of interest in this study.

Ethical consideration

This research adhered to ethical standards and received approval to involve all respondents as participants.

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