THE EFFICIENCY OF COMBINED TRAINING USING CLASSICAL EXERCISES AND CORE STABILITY EXERCISES IN STRENGTH DEVELOPMENT FOR SENIOR HANDBALL PLAYERS

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Abstract

The present paper aims to highlight the effectiveness of strength training through the combined use of classical exercises and core stability exercises, employing the circuit training method, in handball players competing in the National League at the senior level. The subjects of the research are 18 male players from the CSM Vaslui handball team, with an average age of 27.5 years. Over a 12-week period, a training program was implemented, designed by combining exercises specifically aimed at strength development with core stability exercises. The program was applied once a week during technical-tactical training sessions (30 minutes at the beginning of the session, immediately after warm-up) and as part of the physical training sessions (twice a week, 90 minutes each). The tests used targeted the maximal strength level of the lower limbs (4 control tests) and upper limbs (3 control tests). The results, which indicate the strength index levels, showed improvements in all tests from the initial to the final assessment. In conclusion, classical strength development exercises can be effectively combined with core stability exercises to improve the strength level of performance handball players.

Keywords: *strength; core-stability; handball.*

INTRODUCTION

Modern handball has changed significantly in recent decades, becoming a high-speed, intense, and tactically complex sport. The evolution of rules, equipment, and athletes' physical training has led to the emergence of a dynamic style of play that places high demands on players' physical, technical-tactical, and psychological qualities (Wagner et al., 2014). Modern handball involves rapid changes of direction, repeated sprints, jumps, and constant physical contact, which means a high physical intensity. Players must combine explosive strength, reaction speed and movement, anaerobic endurance, as well as resistance to contact in both offensive and defensive phases (Póvoas et al., 2012). The speed of the game has increased significantly, implying limited time for decision-making. Players need to react quickly to changing situations and execute precise actions within a very short time frame. Modern players must be able to perform in multiple positions and quickly adapt to transitions between attack and defense. This requires balanced physical development and a deep understanding of the game. Rapid transitions between offense and defense—and vice versa—are essential for team success. Modern teams seek to capitalize on every counterattack or defensive retreat opportunity, which requires exceptional physical conditioning and the ability to sustain anaerobic effort. Each player has a well-defined role but must also collaborate fluidly within the team system. Defensive systems (6-0, 5-1, 3-2-1) and offensive strategies (with double pivot, 7-player attack) are increasingly sophisticated, requiring tactical intuition and game intelligence (Grupean, 2015). Modern physical training in handball is no longer separate from the specifics of the game. Functional methods, ball-specific exercises, and circuits that replicate the intensity and demands of the match are used. Strength, speed, and agility are developed in contexts as close as possible and consistent with competitive developments (Ghervan, 2007).

This study aims to analyze the possibility of developing specific maximal strength in senior performance handball players using a program that combines the classic circuit for strength development with a strength/speed/core-stability circuit, applied over 12 weeks during the pre-competition/competition period. Since the program is intended to be applied to a handball team competing in the first league during the pre-competition/competition period, we will limit ourselves to a descriptive study.

The study hypothesis starts from the assumption that classic strength development training using the circuit method, combined with a strength/speed/core-stability circuit, will significantly improve specific maximal strength indicators.

METHODOLOGY

1. Participants

The subjects of the research are 18 members of the CSM Vaslui men's handball team, with an average age of 27.5 years. The athletes included in this study compete in the

National League and have practiced performance sport for at least 10 years. The CSM Vaslui men's handball team is a competitive team in the national championship, ranked 8th–9th in the national standings.

2. Research instruments

The tests used aimed to assess the maximal strength level of the lower limbs (4 control tests) and the upper limbs (3 control tests). The 7 tests and the order in which they were performed are:

1. Barbell Bench Press (BBP) – pressing the barbell with the upper limbs, lying supine on a bench, with feet supported on the floor;
2. Barbell Squat (BS) – squatting with the barbell, standing with feet slightly apart laterally;
3. Triceps Rope Pull-down (TRP) – triceps extension at the cable machine, sitting on the gym bench with bent knees and feet resting on the floor;
4. Barbell Hip Thrust (BHT) – lying supine with the back supported on a bench, legs bent with feet resting on the bench, raising the pelvis with the barbell placed on the hips;
5. Barbell Hang Clean (BHC) – from a squat position, feet slightly apart, explosively lifting the barbell first to the chest, then standing up and pushing the barbell overhead by extending the elbows;
6. Lever Lying Leg Curl (LLLC) – flexion and extension of the legs lying supine on the strength training machine bench;
7. Lever Leg Extension (LLE) – lying supine on the strength machine bench, extending and flexing the legs.

Before starting the strength development program, maximal strength evaluation was performed for each participant on these 7 tests to establish the strength level at the study's start and quantify progress at its conclusion.

Maximal strength is defined practically by the 1RM (one-repetition maximum) test and represents the maximum weight a person can lift/press in a single repetition with correct technique for a given exercise. The 1RM test is considered the "gold standard" for measuring dynamic strength in field conditions (non-laboratory). It is widely used by strength coaches to assess athletes' strength capacity, identify possible imbalances between muscle group levels, and calibrate training loads specifically for each individual.

1RM Testing Protocol: Testing maximal strength requires safety precautions (presence of a spotter/assistant, thorough warm-up) and a standardized protocol. Typically, the test begins with a general warm-up, followed by specific warm-up with submaximal weights: for example, performing 6–10 repetitions with about 50% of the estimated 1RM weight, then after a 1–2-minute rest, performing 3–5 repetitions with about 80% of the estimated 1RM.

After warming up, single 1RM attempts begin: the load is gradually increased (usually by increments of about 5–10% of the initial weight for upper body exercises and 10–20% for lower body exercises) and a single repetition is attempted. If successful (correct form, no assistance), the participant rests for 2–4 minutes and tries a heavier weight. This process repeats until the participant can no longer surpass a certain load; the highest weight successfully lifted or pressed represents the 1RM.

Ideally, maximal strength is reached within 3–7 single attempts to avoid fatigue before full strength potential is exhausted. When multiple exercises are used for evaluation (e.g., squat, bench press, deadlift), adequate rest is ensured between tests for different muscle groups, or testing is split across different days to avoid fatigue influence.

By finding the 1RM values in the main exercises (e.g., 1RM squat, 1RM bench press, 1RM hang clean, etc.), the coach can set relative work intensities for the program (e.g., % of 1RM for different repetition ranges) and objectively measure progress (an increase in maximal strength at retesting indicates program effectiveness).

For example, if at the start of the program an athlete's 1RM in squats is 100 kg, strength training can be planned around specific percentages (60–80% 1RM for hypertrophic strength development, 85–95% for maximal strength, >100% for supramaximal or negative training, etc.).

At the end of the 8-week program, the 1RM testing will be repeated to quantify strength gains — a key indicator of program success.

3. Research procedure

The design of the *12-week training program for increasing maximal strength* involved adhering to the principles of progressive overload, specificity, and adequate recovery. Over 12 weeks, the proposed and designed training program was applied, based on combining specific strength development exercises with core stability exercises.

The program consisted of two physical training sessions per week, each lasting 90 minutes, using circuit training methods with 12 classical strength exercises performed on machines or with specific equipment. Between these two training sessions, the program was supplemented once a week with a strength/speed/core-stability circuit consisting of 10 exercises, performed during a technical-tactical training session (30 minutes at the start of the session, immediately after warm-up).

Since the goal was not only to increase maximal strength but also to improve explosive power (strength manifested at high speed), which underlies jumping ability and throwing strength, the program included periods of high load (for absolute strength) as well as explosive executions and sufficient rest intervals to allow neuromuscular system recovery.

4. Structure and Periodization of the Training

Considering the intense nature of strength training sessions, a frequency of three sessions per week was chosen, interspersed between days dedicated to technical-tactical preparation and competitions (for example: strength training on Monday, Wednesday, and Friday; while Tuesday, Thursday, Saturday, and Sunday are reserved for technical-tactical training or competitions). In sports training, it is important that practical applied interventions consider the specificity of the sport when aiming for optimal performance improvement (Zu et al., 2025). Practical research indicates that a frequency of at least three weekly sessions is necessary to achieve a sufficient volume of strength stimulation in a circuit training regime, but at the same time, the number of training days should not be exaggerated, with training intensity being the critical factor for progress. In our study, the technical-tactical training days ensured muscular and neural adaptation, thus preventing overtraining and securing positive adaptations to strength stimuli. Each week of strength training comprised three identical or slightly varied sessions in which the strength circuit was performed. A training session included 3 to 5 circuit sets, depending on the program phase (initially fewer sets for accommodation, increasing volume in the intermediate phase, then reduced towards the end to avoid supramaximal strain). Within a circuit set, the athlete performs each exercise sequentially in the established order, with short breaks between exercises (30–60 seconds, just enough to move between stations and prepare), an approach that allows alternating muscle groups and maintaining high intensity without compromising execution. After completing a circuit, a longer break (5–8 minutes) is taken before starting the next, allowing partial recovery. This method maximizes gym time efficiency and increases metabolic demand; however, the main goal remains strength development. Therefore, emphasis is placed on the quality of each execution and maintaining a high level of effort for every exercise, even when performed in a circuit format. The 12 exercises used in the strength training sessions were: Contralateral Db T-Bench Press; Pull-Ups Classic Grip; Bench Squat; Plate Pullover; Lying Leg Curl; Machine Triceps Extension; Resistance Band Abduction – Bosu; Resistance Band Adduction; Neutral Grip Shoulder Press, Barbell Hang Clean; Quadriceps Extension; Barbell Hip Thrust.

In the technical-tactical training program, the strength/speed/core-stability circuit included the following 10 exercises: stepping on a stepper with the opposite knee raised at a 90° angle; balancing on a Bosu – moving the foot in the four cardinal directions while simultaneously pushing a sandbag (disc) forward; gradual lowering into a push-up over 3 seconds followed by an explosive return to the initial position; deceleration – standing on a Bosu while holding a resistance band in tension, lowering into a lateral lunge; Pull Over; Hamstring exercise on a Swiss ball; ladder drills; passing an 800g medicine ball while standing on one leg on a Bosu in various ways; halo exercise with a sandbag; lateral twists with a sandbag while seated on a Bosu with legs elevated.

The dosing was as follows: 3 sets, each exercise repeated for 30 seconds, 15 seconds rest between stations, 30 seconds rest between sets, for a total work time of 30 minutes.

The training period was structured over 12 weeks (Table 1). The program was designed with progressive variations in intensity (% of 1RM – maximal strength) and volume (number of sets and repetitions). Initially, the emphasis was on moderate volume and technique refinement, followed gradually by heavier loads with fewer repetitions, and in the final phase, volume was reduced to allow maximal strength manifestation and avoid excessive central nervous system fatigue.

Table 1. Periodization of the two strength training programs over 12 weeks

Week	Training days - strength	Intensity %1RM	SERIES	REPETITIONS	Evaluation
S1	July 08 and 12, 2024	50 - 60	3	15-20	1RM_IE
S2	July 15 and 19, 2024	60 - 65	4	10-15	
S3	July 22 and 26, 2024	70	3	10-15	
S4	July 29 and August 02, 2024	75	4	10-12	
S5	August 05 and 09, 2024	75	4	10-12	
S6	August 12 and 16, 2024	80	4	08-10	
S7	August 19 and 23, 2024	80	4	06-08	
S8	August 26 and 29, 2024	85	5	06-08	
S9	September 02 and 05, 2024	90	5	04-06	
S10	September 09 and 12, 2024	90	5	04-06	
S11	September 16 and 19, 2024	95	3	2-3	
S12	September 23 and 26, 2024	100/50	Test/2series		1RM_FE

RESULTS

The processed results are presented in Table 2. The statistical processing includes the arithmetic mean, the difference between the initial test mean and the final test mean, the standard deviation, and the coefficient of variation for the 7 tests assessing strength capacity.

Table 2. Statistical results obtained from the initial and final testing of the athlete group

	M (Kg)	Diff M FE_IE (kg)	S	CV
BBP_IE	103.06	16.39	11.52	11.18
BBP_FE	119.44		12.11	10.14
BS_IE	126.94	16.39	19.94	15.70
BS_FE	143.33		16.27	11.35
TRP_IE	74.17	10.28	7.33	9.88
TRP_FE	84.44		7.65	9.06
BHT_IE	142.22	12.22	32.64	22.95
BHT_FE	154.44		35.02	22.67
BHC_IE	63.50	6.17	9.76	15.37
BHC_FE	69.67		9.15	13.14

LLLC_IE	73.89	7.56	8.82	11.94
LLLC_FE	81.44		7.02	8.62
LLE_IE	68.56	3.78	1.92	2.80
LLE_FE	72.33		2.40	3.32

Legend: M = mean; S = standard deviation; CV = coefficient of variation; DiffM = Difference between means; IE = initial evaluation; FE = final evaluation; BBP = Barbell Bench Press; BS = Barbell Squat; TRP = Triceps Rope Pull-down; BHT = Barbell Hip Thrust; BHC = Barbell Hang Clean; LLLC = Lever Lying Leg Curl; LLE = Lever Leg Extension.

For the BBP test, it is observed that the arithmetic mean increased by 16.39 kg from 103.06 kg in the initial evaluation (IE) to 119.44 kg in the final evaluation (FE). The standard deviation increased from 11.52 in IE to 12.11 in FE, which indicates a decrease in group homogeneity, while the coefficient of variation decreased from 11.18 in IE to 10.14 in FE, highlighting a better clustering of values around the mean. Thus, we can emphasize that the strength of the bench press from the dorsal lying position improved considerably.

For the BS test, which assessed lower limb strength, an average value of 126.94 kg was recorded in IE and 143.33 kg in FE, showing a difference of 16.39 kg. The standard deviation decreased by 3.77, from 19.94 in IE to 16.29 in FE, indicating improved group homogeneity, and the coefficient of variation dropped by 4.35, from 15.70 in IE to 11.35 in FE, indicating that the subjects' values in FE were closer to the mean. We highlight that the average value in the squat test improved by 16.29 kg following the intervention.

Regarding the TRP test, the mean value increased by 10.28 kg, from 74.17 kg in IE to 84.44 kg in FE. The standard deviation increased from 7.33 in IE to 7.65 in FE, showing decreased group homogeneity, while the coefficient of variation decreased from 9.88 in IE to 9.06 in FE, emphasizing a concentration of individual values toward the mean. This shows an improvement in triceps extension strength using the lat pulldown machine.

Looking at the statistical processing for the BHT test, the results show a mean difference of 12.22 kg from 142.22 kg in IE to 154.44 kg in FE. The standard deviation increased from 32.64 in IE to 35.02 in FE, indicating decreased group homogeneity, while the coefficient of variation decreased slightly from 22.95 in IE to 22.67 in FE, which highlights a reduced variability between individual values relative to the mean. We consider that the improvement in strength in the hip thrust test, performed with the barbell placed at hip level while lying on a gym bench with bent knees and feet on the floor, is a result of the applied intervention.

For the BHC test, the statistical analysis shows an increase in the mean value by 6.17 kg, from 63.50 kg in IE to 69.67 kg in FE, a decrease in standard deviation from 9.76 in IE to 9.15 in FE, highlighting improved group homogeneity, and a decrease in the coefficient of variation from 15.37 in IE to 13.14 in FE, indicating a reduced spread of individual values around the mean. These improvements support the possibility of enhanced overhead barbell lifting strength.

From the processed data of the LLLC test, a force increase of 7.56 kg was observed, from a mean value of 73.89 kg in IE to 81.44 kg in FE. The standard deviation decreased from 8.82 in IE to 7.02 in FE, indicating improved homogeneity, and the coefficient of variation decreased from 11.94 in IE to 8.62 in FE, showing a better distribution of individual values around the mean. This evolution highlights increased lower limb flexion strength in the leg press test performed from the dorsal lying position with bent legs.

Regarding the LLE test, which assessed lower limb extension strength, an increase in the mean value of 3.78 kg was recorded, from 68.56 kg in IE to 72.33 kg in FE. The standard deviation increased from 1.92 in IE to 2.40 in FE, indicating decreased group homogeneity, and the coefficient of variation increased from 2.80 in IE to 3.32 in FE, meaning a greater spread of individual values relative to the mean in FE.

DISCUSSION AND CONCLUSION

The objective of this observational study was to investigate the effects of a 12-week training program (covering the pre-competition and competition periods) aimed at the potential development of maximal strength in performance handball players, through a program that combined classical strength training with a strength/speed/core-stability circuit.

The collected and processed data suggest that combined training produces effects in the process of strength improvement. The increases in mean values from the initial evaluation (IE) to the final evaluation (FE) were: +16.39 kg in the bench press with upper limbs from the dorsal lying position (BBP) and in the squat with the barbell on the shoulders while standing (BS); +10.38 kg in arm extension while seated on a bench with elbows bent at shoulder level (TRP); +12.22 kg in hip thrust with the barbell from the dorsal lying position on the bench, feet placed on the bench with knees bent (BHT); +6.17 kg in the barbell lift from the ground overhead from the squat position (BHC); +7.56 kg in leg flexion from the prone lying position on the bench with knees extended (LLLC); and +3.78 kg in leg extension while seated on the bench (LLE), highlighting an increase in strength levels.

We consider the increase in strength across these seven tests to be the result of using a combined training approach that included classical strength exercises alongside stability exercises. A meta-analysis conducted by Rodriguez et al. in 2025, which aimed to highlight the effects of abdominal muscle stability training on handball throwing performance, demonstrated an increase in throwing speed among handball players. Moreover, “traditional weight training, primarily using the barbell for compound lifts, produced the most significant and robust results” in achieving sports performance (Hadjisavvas et al., 2024).

The increase in mean strength values across the seven assessment tests is due to the combined training method incorporating classical strength exercises with stability exercises. Therefore, we consider that the obtained and highlighted results validate the study hypothesis, according to which *classic strength development training using the circuit method, combined with a strength/speed/core-stability circuit, will significantly improve specific maximal strength indicators.*

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