THE IMPORTANCE OF USING CIRCUIT TRAINING IN THE DEVELOPMENT OF CONDITIONAL AND COORDINATIVE ABILITIES OF MALE U17 HANDBALL PLAYERS

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ABSTRACT. The necessity of a proper physical training of athletes and their harmonious development of also implies making them accustomed with the practice of circuit training within handball specific training sessions. This ensures the mastery of a complex set of exercises and its methods of execution. **Aims:** We started from the premise that the chaining of several handball specific exercises within a training circuit can be beneficial for the development of conditional and coordinative abilities of the male U17 handball players. **Methods:** The method used was mainly the experimental one, speed testing in different directions was performed, with emphasis on execution, acceleration and force speed, as well as agility and general coordination. Data interpretation was performed by applying the statistical-mathematical method, the method of graphical representations. **Results:** The results show a statistically significant difference between mean results obtained by the subjects of the two groups in the "Training circuit 1" test for testing speed in different directions, with emphasis on execution, acceleration and force speed, as well as agility and general coordination, the average being 31.98 sec. for the experiment group and 34.48 sec. for the control group. As a result, the average of the experiment group is lower by 2.51 sec. (7.27%). **Conclusions:** The higher the motor skill indicators, the more the technical-tactical abilities of male U17 handball players will make the difference in achieving maximum efficiency.

Key words: male handball, U17, circuit training, conditional and coordinative abilities.

REZUMAT. *Necesitatea aplicării parcursurilor aplicative în dezvoltarea capacităților condiționale și coordinative ale jucătorilor de handbal masculin, juniori II.* O pregătire fizică bună și o dezvoltare armonioasă a sportivilor, impune obișnuirea acestora cu practicarea parcursurilor aplicative în

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cadrul antrenamentelor specifice disciplinei handbal, care să le asigure cunoaşterea până la automatizare a unui complex de exerciţii şi a modului lor de execuţie. **Obiective:** Am plecat de la premiza că înlănţuirea mai multor structuri specifice jocului de handbal în cadrul unui parcurs aplicativ poate fi benefică dezvoltării capacităţilor condiţionale şi coordinative ale jucătorilor de handbal masculin, juniori II. **Metode:** S-a utilizat în principal metoda experimentului, s-a realizat testarea vitezei pe direcţii diferite, cu accent pe viteza de execuţie, viteza de accelerare, viteza în regim de forţă precum şi agilitatea şi coordonarea generală, iar interpretarea datelor s-a realizat prin aplicarea metodei statistico-matematice, metoda reprezentărilor grafice. **Rezultate:** Rezultatele indică o diferenţă semnificativă statistic între mediile rezultatelor obţinute de subiecţii celor două grupe la testul „Parcurs aplicativ 1" pentru testarea vitezei pe direcţii diferite, cu accent pe viteza de execuţie, viteza de accelerare, viteza în regim de forţă precum şi agilitatea şi coordonarea generală, media având valoarea 31.98 sec. la grupa experiment, respectiv 34.48 sec. la grupa de control. Rezultă că media este mai mică la grupa de experiment cu 2.51 sec. (7.27%). **Concluzii:** Cu cât indicatorii motrici sunt la cote superioare, cu atât capacităţile tehnico-tactice ale jucătorilor de handbal masculin, juniori II vor face diferenţa în atingerea eficienţei maxime.

Cuvinte cheie: *handbal masculin, juniori II, parcursuri aplicative, capacităţi condiţionale şi coordinative.*

Introduction

Handball is defined as a dynamic sport, in which players use their hands to dribble, pass and throw the ball at the opponent's goal. Therefore, handball is characterized by highly developed motor skills such as coordination, speed and agility, endurance, reaction speed and explosive power (Milanese, C., et.al., 2012, pp. 199-204).

Physical training provides the energy required for performance, stimulating the increase of functional and morphological indices and, consequently, of motor qualities. Thus, the increase of the body's general capacity for effort will help accentuate the technical-tactical skills required by competition regulations of the particular discipline practiced by the athlete (Nicu, A., 1993).

Good physical training and harmonious development of athletes implies their habituation with the practice of training circuits within handball specific training. This ensures the mastery of a complex set of exercises and their execution on an automatic level. Apart from the fact that they strengthen athletes' health and their psycho-physical balance, they also lay the foundations for a multilateral and harmonious development of the body and allow for a rich and assorted set of motor skills.

Training circuits are complex structures, consisting of basic motor skills (walking, running, jumping, shooting, catching), applied motor skills (climbing, balance, crawling, lifting and transporting weights, traction, pushing) and technical elements from sports disciplines, ensuring a wealth of motor resources in physical training, regardless of the existing material conditions.

Circuit training has shown an increased efficiency in the development of motor skills, because they contain elements of competition which increase efficiency due to their mobilizing nature, and the increase in repetitions makes the activity more attractive, more stimulating, stimulating the interest of athletes.

An all-round physical training and the proper development of general coordination skills implicitly leads to a faster and smoother development of specific coordinative abilities.

With the help of coordinative abilities, we can achieve the highest level of general coordination, from partial movements to the formation of general ones, if they are coordinated in a consistent way (Esfahankalati, A., et.al., 2013, pp. 42-46). They are important in the game of handball and their improvement is necessary from an early age. In particular, coaches who work with young players will need to include the development of coordination in their daily training program (Esfahankalati, A., Venkatesh, C., 2013, pp. 42-46). Thus, the efficient use of tactical capabilities is ensured, in situations that undergo continuous changes (Blumenstein, B., et.al., 2007, pp. 62-67). The higher the degree of coordination skills that are specific to the game of handball, the more complex actions an athlete can perform at progressively higher speeds, which explains the restriction of movements by the defenders' action, for example (Starosta, W., 2006, pp. 9-23).

Coordinative skills allow the execution of a group of qualitative movements, and their insufficient training limits the ability to perform at a higher level. (Blumenstein, B., 2007, pp. 62-77). Therefore, a good development of coordination skills provides a solid basis for fast and efficient learning, stabilization and variation of technique, as well as their successful execution in the moments of the game. (Pramanick, P., 2011, pp. 98).

It is assumed that a high level of basic motor skills, situational, cognitive and functional, is the essential condition for effective learning of new motor structures, their improvement and successful implementation (Hirtz, P., ș.c., 2002, pp. 19-28).

It is to be noted that, in the game of handball, it is not the perfection of technical execution that determines success, but its speed, precision and adaptation to momentary conditions.

Conditional and coordinative skills should be taken into account in the planning and organization of training programs as important elements of a complex training process of U17 male handball players, as it exerts a considerable influence on technical and tactical skills and increase their effectiveness.

Aims

The aim of this experiment is to achieve a significant increase in conditional and coordinative abilities by capitalizing on the specific elements of the game of handball in a homogeneous and unitary system, through circuit training. We started from the premise that the chaining of several structures specific to the game of handball within a training circuit can be beneficial to the development of conditional and coordinative abilities of male U17 handball players.

Materials and methods

The experimental research began in September 2018, when we identified the two groups of subjects, aged 15 and 16 (2003 and 2002 born), who practice organized handball systematically and continuously, as it follows: the experimental group, consisting of 15 athletes of the handball team Bucharest Municipal Sports Club (CSM), and the control group, consisting of 17 athletes of the handball team of Bucharest School Sport Club No. 2 (CSS nr.2). The experimental group underwent a training program consisting of general and multilateral physical training methods in the form of training circuits, for 30 weeks, three times a week, for 15 minutes (on Mondays, Tuesdays and Wednesdays).

At the beginning and at the end of the research period, the "**Training circuit 1**" test was applied to both groups. The test was designed to evaluate the speed indices specific to the various forms of attack and defense phases in U17 men's handball.

Aim: speed testing in different directions and angles, involving forward, lateral and backward movements, the ability to rotate in different directions and at different angles, with emphasis on execution, acceleration and force speed (lower limb expansion), agility and body control.

Equipment: gym bench, 20 training cones, stopwatch, handball, whistle, handball goal, tape measure, adherent surface.

*Work procedure***:** After the whistle, from standing start position at the starting line (a), the athlete performs a 4 m sprint, to workshop 1, where, on the right side of the cone, he executes a figure eight run (there and back) between 2 longitudinally arranged cones located at a distance of 2 m between them, all the while facing forward, in the direction of movement. This is followed by a 3 m sprint, until workshop 2, where, on the right side of the cone, the athlete performs a figure eight side run (right then left), between 2 transversely placed cones and at a distance of 2 m between them, all the while facing forward, in the direction of movement.

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Then he executes a 2 m sprint, to workshop 3, where the athlete, on the left side of the cone, performs a winding run, facing forward, in the direction of movement, among 4 longitudinally arranged cones, located at a distance of 1m between them. Next is a 2 m sprint, to workshop 4, where the athlete, from the right side of the 3 m long gym bench, performs 4 successive diagonal jumps, feet close together, over the bench, all the while facing forward, in the direction of movement.

It is followed by a 4 m sprint, to workshop 5, where the athlete, on the right side of the line of cones, performs a left side run facing the handball goal, among the first row of 4 transversely placed cones and at an interval of 1 m between them. At the end of the row of cones, the athlete sprints forward 2 m, towards row 2 of 4 transversely placed cones at an interval of 1 m between them and continues his right side run facing the handball goal, towards the last cone.

Next is a sprint of 3 m diagonally to the left, to workshop 6. Here the athlete, on the left side of the cone, runs facing the handball goal, there and back, bypassing the 2 longitudinally placed cones, at a distance of 2 m between them. The athlete continues the sprint of 3 m diagonally to the right, facing the handball goal, to workshop 7. From here, he picks up the handball from the ground, from a set point, with both hands. The athlete makes a 3 m free dribble diagonally, towards the left cone, towards workshop 8.

From here, alternately using both hands, he continues the dribbling, this time running in figure eight, around 2 transversely placed cones, at an interval of 2 m between them, always facing the goal. Next is 4 m free dribbling diagonally to the right, towards workshop 9, at the 9 m line (b). From here, the athlete performs an overarm jump shot, without crossing the 9 m line (b) at take-off, from the foot opposite the shooting arm. After the ball thrown towards the handball goal reaches the goal net, the timer stops.

Methodological instructions

The setup of the training circuit should begin with workshop 9; each subject is entitled to two attempts as warm up; each subject is timed separately, from the starting line (a) to the ball touching the net of the goal, after the overarm jump shot from the 9 m line (b); the subject performs the test only once and time will be recorded with an accuracy of 0.01 seconds; the following penalty criterion will be used: 2 seconds per violation whenever the athlete deviates from forward facing movement.

a. Subject one; b. Subject two; 1. Subject (a) picks the ball up from the first cone and executes two bounced passes with subject (b); 2. Lateral running and touching the left row cones with left hand and the right row cones with right

hand; between the two rows the subject runs facing forward; 3. Winding run forward through 4 cones; 4. Running round two cones facing forward; 5. 10 left and right jumps on both feet between cones (c), (d); 6. Running forward to cone (e), then backward movement to cone (f), sideways running between cones (f) and (g), forward running towards workshop (7); 7. Receiving handball with both hands; 8. Dribbling and shooting on goal by various procedures; h. 9 m line; i. Retrieving the ball and returning to workshop (7); j. Running back into formation; Legend :1) The first cone where the subjects receives the ball is 5 m away from the starting line; 2) two rows of 3 cones each, 6 m away from workshop (1), the distance between rows being 4 m, the distance between cones 3 m; 3) 4 successively placed cones 4 m away from workshop (2), the distance between cones being 2 m; 4) 2 transversely placed cones 6 m away from workshop (3), the distance between the two cones being 4 m; 5) Two successively placed cones (c) and (d) 4 m away from workshop (4), the distance between the two cones being 8 m; 6) 3 cones placed in an equilateral triangle 4 m away from workshop (5), the distance between cones being 6 m; 7) Receiving a handball with both hands.
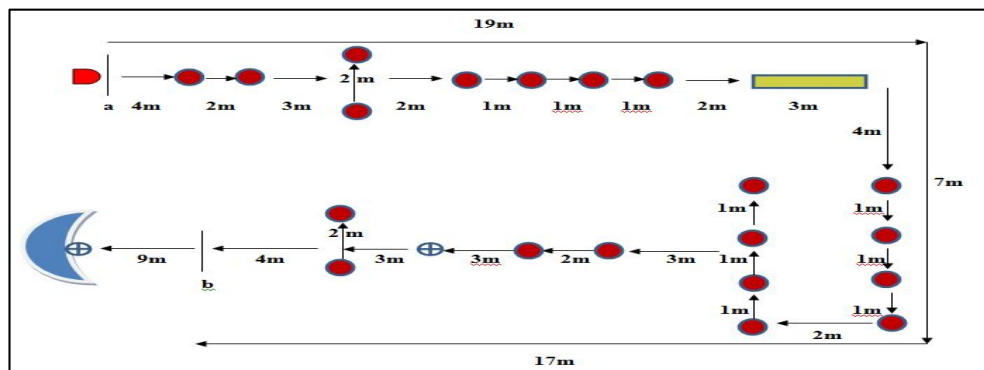
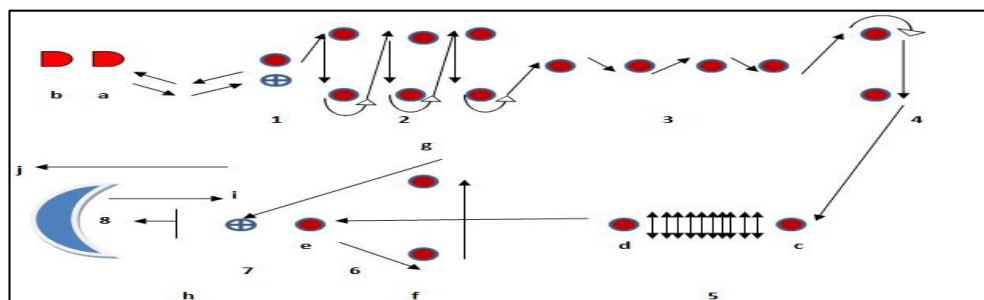

Figure 1. „Training circuit 1" test

Figure 2. Training circuit 1

a. Subject one; b. Subject two; 1. Subject (a) picks the ball up from the first cone and executes two passes with subject (b), after the second pass the handball stays at the first cone; 2. 4 successive jumps with both feet over the gym bench; 3. Sideways run from left to right between two rows of cones each consisting of 4 cones, next time running in the opposite direction; 4. Running round a cone; 5. Jumping over cones with legs apart and touching the cone, landing with feet close together between cones, 4 times; 6. 4 jumps over gym bench with both feet; 7. Receiving a handball with both hands; 8. Dribbling and jump shot; c. 9 m line; d. Retrieving the ball and returning to workshop (7); e. Running back into formation. Legend: 1) The first cone is 4 m away from the starting line; 2) The gym bench is 4 m away from workshop (1); 3) 2 transversely placed rows of 4 cones each, the distance between rows being 4 m, the distance between cones 2 m; 4) Cone 4 m away from workshop (3); 5) 4 successively placed cones 4 m away from workshop (4), the distance between cones being 80 cm; 6) Gym bench 4 m away from workshop (5); 7) handball placed 6 m away from workshop (6).
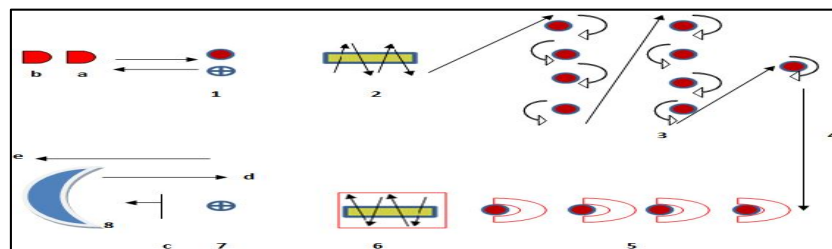

Figure 3. Training circuit 2

a. Subject; 1. Rotation round 3 cones from left to right, next time from right to left; 2. Touching the right cone with right hand and left cone with left hand, lateral shuffle between the two transversely placed cones, next time in the other direction; 3. Going round the two cones facing forward and backward, next time in the other direction; 4. Running round a cone; 5. Rotation round for cones running diagonally; 6. Receiving a handball with both hands; 7. Dribbling round two transversely placed cones, next time in the other direction; 8. Jump shot from the 9 m line (b); b. 9 m line; c. Retrieving the ball from the goal and running back to workshop (6); d. Running back into formation. Legend: 1) The first of the 3 cones is 3 m away from the starting line, the distance between the cones being 1 m; 2) The two transversely placed cones are 3 m away from workshop 1, the distance between the cones being 1 m; 3) The first of the two successively placed cones is 3 m away from workshop (2), the distance between

the cones being 4 m; 4) Cone 10 m away from workshop (3); 5) Four cones placed in a trapezium with the side of 4 m, 6 m away from cone (4); 6) Handball placed 4 m away from workshop (5); 7) Two transversely placed cones 4 m away from the handball, the distance between the two cones being 4 m; 8) Jump shot from the 9 m line (b).
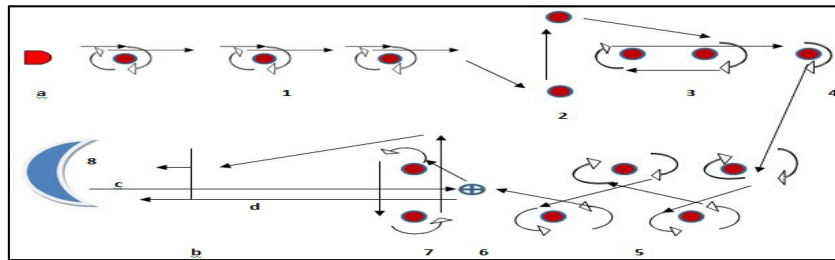

Figure 4. Training circuit 3

Results

Table 1. Experimental research – Experimental group
Initial and final testing - „Training circuit 1" test

No.	Initials	Year of birth	Age	„Training circuit 1" test - Unit – Seconds	
				Initial	Final
1	P.A.	2003	15	32.93	30.61
2	P.V.	2002	16	33.15	30.77
3	D.C.	2002	16	33.24	30.95
4	Z.A.	2002	16	33.48	31.04
5	C.C.	2002	16	33.57	31.32
6	C.S.	2002	16	33.88	31.57
7	V.D.	2002	16	34.04	31.79
8	B.A.	2003	15	34.17	32.09
9	D.D.	2003	15	34.42	32.18
10	M.F.	2003	15	34.79	32.44
11	T.F.	2003	15	34.91	32.53
12	C.A.	2003	15	35.08	32.81
13	L.M.	2003	15	35.22	32.84
14	J.A.	2002	16	35.28	33.14
15	K.A.	2002	16	35.41	33.58

Table 2. Experimental research – experimental group – Analysis of statistical-mathematical indices before and after the training program - „Training circuit 1" test

Statistical index	I.T.	F.T.	Statistical index	F.T.-I.T. differences	
Mean	34.24	31.98	Mean	-2.26	
Median	34.17	32.09	Progress	6.6%	
Standard deviation	0.85	0.92	95% C.I.	(-2.34; -2.18)	
Minimum	32.9	30.6	Standard deviation	0.15	
Maximum	35.4	33.6	Dependent T-test	t	p
Amplitude	2.5	3.0		57.63	<0.001
Coefficient of variation	2.5%	2.9%	Effect size	14.88	

For the experimental group, the "Training circuit 1" test for testing speed in different directions, with emphasis on execution, acceleration and force speed, as well as agility and general coordination, showed a drop in mean execution time at the final testing by 2.26 sec. The progress made is 6.6%. The difference in averages is within the confidence interval (-2.34; -2.18). Variance is homogenous at both testing. The difference between means is large to very large and statistically significant, $p<0.001$, with t=57.63 and df=14. **Chart 1** shows the recorded means, while **chart 2** the individual differences between final and initial results.
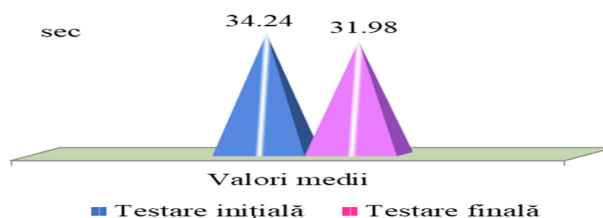

Chart 1. Experimental research – Experimental group – Initial and final testing – Mean values of individual results - „Training circuit 1" test

Chart 2. Experimental research – Experimental group – Initial and final testing – Differences between final and initial individual results - „Training circuit 1" test
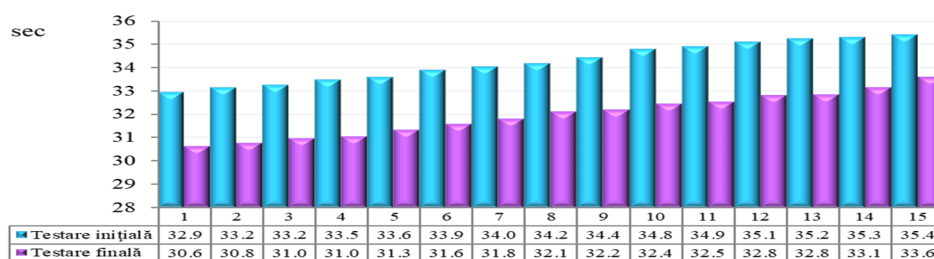
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Testare inițială	32.9	33.2	33.2	33.5	33.6	33.9	34.0	34.2	34.4	34.8	34.9	35.1	35.2	35.3	35.4
Testare finală	30.6	30.8	31.0	31.0	31.3	31.6	31.8	32.1	32.2	32.4	32.5	32.8	32.8	33.1	33.6

Chart 3. Experimental research – Experimental group – Initial and final testing – Final and initial individual results - „Training circuit 1" test

Table 3. Experimental research – Control group
Initial and final testing – „Training circuit 1" test

No.	Initials	Year of birth	Age	„Training circuit 1" test Unit – Seconds	
				Initial	Final
1	B.D.	2003	15	33.14	32.88
2	P.A.	2003	15	33.44	32.91
3	M.C.	2003	15	33.61	33.32
4	P.L.	2002	16	33.79	33.55
5	V.C.	2003	15	34.04	33.70
6	N.C.	2003	15	34.32	33.78
7	N.R.	2002	16	34.74	33.94
8	C.A.	2003	15	34.93	34.48
9	S.A.	2003	15	34.98	34.69
10	G.V.	2003	15	35.04	34.77
11	C.A.	2003	15	35.36	34.85
12	B.A.	2003	15	35.66	35,12
13	N.D.	2003	15	35.85	35.26
14	A.M.	2002	16	36.03	35.33
15	B.D.	2002	16	36.27	35.75
16	B.V.	2003	15	36.56	35.79
17	O.R.	2002	16	36.72	36.09

Table 4. Experimental research – control group – Analysis of statistical-mathematical indices before and after the training program - „Training circuit 1" test

Statistical index	I.T.	F.T.	Statistical index	F.T.-I.T. differences	
Mean	34.97	34.48	Mean	-0.49	
Median	34.98	34.69	Progress	1.4%	
Standard deviation	1.12	1.02	95% C.I.	(-0.58; -0.39)	
Minimum	33.1	32.9	Standard deviation	0.18	
Maximum	36.7	36.1	Dependent T-test	T	p
Amplitude	3.6	3.2		11.09	<0.001
Coefficient of variation	3.2%	2.9%	Effect size	2.69	

For the control group, the "Training circuit 1" test for testing speed in different directions, with emphasis on execution, acceleration and force speed, as well as agility and general coordination, showed a drop in mean execution time at the final testing by 0.49 sec. The progress made is 1.4%. With a confidence of 95% the difference in averages is within the interval (-0.58; -0.39). Variance is homogenous at both testings. The difference between means is large to very large and statistically significant, p<0.001, with t=11.09 and df=16. **Chart 4** shows the recorded means, while **chart 5** the differences between final and initial results.
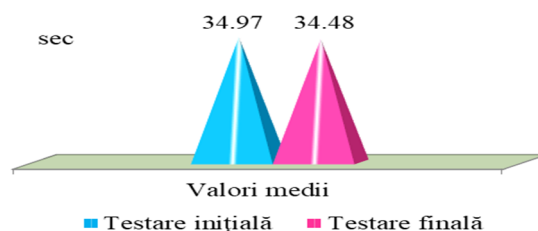

Chart 4. Experimental research – Control group – Initial and final testing – Mean values of individual results - „Training circuit 1" test

Chart 5. Experimental research – Control group – Initial and final testing – Differences between final and initial individual results - „Training circuit 1" test
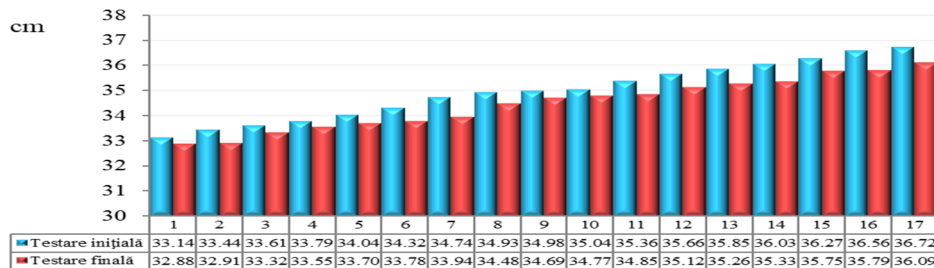
Chart 6. Experimental research – Control group – Initial and final testing – Final and initial individual results - „Training circuit 1" test

Table 5. Experimental research - Experimental vs control group – Comparative analysis of mean results in view of statistical-mathematical indices after the training program - „Training circuit 1" test

GROUP	Mean	Mean diff.	Median	Standard deviation	Minimum	Maximum	Amplitude	Coeff. variation
Experimental	31.98	-2.51	32.09	0.92	30.61	33.58	2.97	2.9%
Control	34.48		34.69	1.02	32.88	36.09	3.21	2.9%

Table 6. Experimental research – Independent T-test - „Training circuit 1" test

Test Levene for equality of variances		Equal variance ?	T-test for equality of variance				Effect size
F	Sig.		Mean difference	T	df	P	
0.263	0.612	YES	-2.51	7.272	30	0.000	2.58

The independent T-test for equality of variances, with p<0.001<0.05 and df=30, shows a statistically significant difference between the mean results recorded by the subjects of the two groups when performing the "Training circuit 1" test for testing speed in different directions, with emphasis on execution, acceleration and force speed, as well as agility and general coordination. The mean value is 31.98 sec. for the experimental group and 34.48 sec. for the control group, meaning that the experimental group mean is shorter by 2.51sec. (7.27%). The effect size (2.58) indicates a large to very large difference between the mean values of the two groups. Variance is homogenous at both testing. **Chart 7** shows the mean values of subjects from both groups at the final testing.
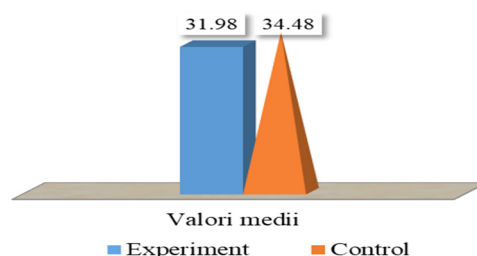
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Chart 7. Experimental research – Experimental vs control group – Mean test values - „Training circuit 1" test

Discussion and conclusions

Many performances achieved by athletes, regardless of their sport, are due to the introduction of new elements in training by the teacher-coaches: resources, training methods, effort quantification, training system, etc.

The novelties, the innovations, the personal imprint of the teacher-coach, has in most cases meant, for the athletes or the team, the added value which has determined the winner during a sporting competition. Capitalizing on the potential of athletes at the highest levels is the main goal of every effort in training plans, an objective often accomplished due to the coach's skill to achieve an optimal ratio between specific and physical training.

While, in the case of male U17 handball players, a lot of the training time is allocated to sports specific training, we consider that physical training can also be improved by introducing resources and methods which can better harness their bio-psycho-motor potential.

Following the independent T-test for equality of variance, with $p<0.001 <0.05$ and $df=30$, the experiment has led us to observe a statistically significant difference between the mean values recorded by the subjects from the two groups after performing the "Training circuit 1" test for testing speed in different directions, with emphasis on execution, acceleration and force speed, as well as agility and general coordination. The mean value of the experimental group was 31.98 sec. while the control group had 34.48 sec. The result is a shorter time of execution by the experimental group by 2.51 sec. (7.27%).

There is a strong need to increase the importance of physical training in the training plans of handball coaches. This should be the basis for consolidating and improving the sports specific training of the male U17 handball player. The higher motor indicators are, the more the technical-tactical abilities of male U17 handball players will be able to make the difference in achieving maximum efficiency.

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