

ASSESSING COORDINATION ABILITIES IN ROMANIAN WATER POLO PLAYERS AGED 10-12 USING THE BRUININKS-OSERETSKY TEST BATTERY

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Abstract. *The main purpose of the study is to assess the development level of coordination abilities in 61 water polo players aged 10-12 years using the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2). This test battery was designed for specialists, providing them with an effective and reliable tool to measure fine and gross motor skills. After analysing the test battery, we applied only five out of the eight subtests (the other three were considered irrelevant for the game of water polo). The tests used in our study aimed at measuring: fine motor precision (FMP), fine motor integration (FMI), bilateral coordination (BC), balance (BAL), upper limb coordination (ULC). The results were statistically interpreted using IBM SPSS v. 12, SmartPLS and Microsoft Excel. We chose these programs for their accurate calculation of mean differences between the obtained scores but also for their interpretations of the t-Test at the significance thresholds required for each subtest. Most of the selected athletes achieved below-average scores for: FMI (score = 2.54), BC (score = 2.85), BAL (score = 2.84), FMP (score = 3.07), ULC (score = 3.23). In order to achieve superior performance, athletes whose scale score is 20-24 and ideally over 25 should be selected. In conclusion, the testing provided essential and relevant information on the level of manifestation of coordination abilities in athletes, allowing specialists to implement specific exercises for the development of coordination abilities in the training process.*

Keywords: *coordination abilities, water polo, performance, training, Bruininks-Oseretsky Test.*

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Introduction

Motor activity is the essence of the coexistence of all species in the universe. The human being, by its nature, is in permanent motor activity, except for the moments of passive rest.

The engagement of young people in various motor activities determine the formation of their personality, thinking and behaviour. Persons who realizes such activities in turn become promoters of physical education as an educational factor (Bălan et al., 2012).

Documents attesting to sports competitions date back over three millennia. They mention preparations for various military or hunting actions involving team or individual hand-to-hand combat, throwing objects (stones, spears) and running races. With the first Olympic Games in 776 BC, which included events such as foot and chariot races, wrestling, jumping, discus and javelin throwing, the ancient Greeks introduced formal sports to the world (Bellis, 2021).

The game of water polo begins its journey around the world in the late 1800s. According to certain historians, it originated in America, and according to others, in England. It is certain that, in the period 1889-1900, nations such as Hungary, Belgium, Austria, Germany or France adopted the rules of the Scots, who are considered the fathers of water polo in Europe. By 1900, water polo was so popular that it became the first team sport to be included in the Olympic Games programme where it has remained ever since (Collegiate Water Polo Association, n.d.).

From the first official match until today, water polo has developed due to changes in the game rules but mainly due to scientific research, primarily on human motor skills. Specialists such as Tudor et al. (2022) outline in their study the somatic and motor profile of children.

“Water polo requires a greater investment in studies that support eventual decisions regarding regulatory changes to effectively impact game evolution” (Canossa et al., 2022, p. 11)

Moanță et al. (2013) believe that, in order to achieve valuable athletic performance, the training concepts should be reconsidered in parallel with choosing the most effective training methods that simultaneously address all training components aimed at fully developing the athletes' potential and abilities. Significant progress has been noted in the development of strength, modification of the involved areas, reduction of the adipose tissue layer, and improvement of the quality of life (Țifrea et al., 2015).

“The Bruininks-Oseretsky Test of Motor Proficiency was examined in an effort to establish its credibility as one of the most widely used tests of motor development in children. The presentation of the test is excellent.” (Hattie & Edwards, 1987, p. 104)

The Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) was later revised and published as the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) (Bruininks & Bruininks, 2005). “The BOT-2 is an individually administered measure of fine and gross motor skills of children and youth, 4 through 21 years of age. It is intended for use by practitioners and researchers as a discriminative and evaluative measure to characterize motor performance, specifically in the areas of fine manual control, manual coordination, body coordination, and strength and agility. The BOT-2 has both a Complete Form and a Short Form.” (Deitz et al., 2007)

The outcome of the study by Duger et al. (1999) reveals that the Bruininks-Oseretsky Test “can be useful to investigate unexplored aspects of motor development”. The Bruininks-Oseretsky Test proves its usefulness in investigating motor proficiency for both descriptive and evaluative purposes (Wilson et al., 1995).

The pace of execution and the alternation between exercise and muscle relaxation are very important for athletes (Vasile, 2014). Marinescu et al. (2018) place emphasis on measuring bilateral coordination and body balance in water polo players through non-specific means and establish the appropriateness of research on these topics, which has encouraged us to study, also using the above-mentioned test battery, coordination abilities such as rhythm, static and dynamic balance in its complexity, segmental and general dynamic coordination,

spatiotemporal orientation, ambidexterity, hand-eye coordination, movement speed and precision, tempo, agility, kinaesthetic differentiation, combinatory ability, adaptive ability, etc.

This research *aims* to measure coordination abilities through the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), applied to 61 water polo players from six sports clubs, who are the representative mass of the selection in this sports discipline for the city of Bucharest. Thus, a number of items/ exercises are identified that help us to design some tests necessary for the selection in the game of water polo but also to measure coordination abilities during the training specific to this sports discipline.

The *research question* of the present study is the following:

- Which is the level of coordination abilities in water polo preadolescent players by using the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)?

Methodology

Participants and Procedure

The research participants are athletes registered with the Romanian Water Polo Federation. Sixty-one athletes aged 10-12 years old were selected from six clubs in Romania as follows:

- “Steaua” School Sports Club – 10 athletes
- “Steaua” Army Sports Club – 10 athletes
- School Sports Club No. 1 – 10 athletes
- “Emil Racoviță” National College – 11 athletes
- “Triumf” Sports Club – 10 athletes
- “Rapid” Sports Club – 10 athletes

The athletes were tested between October and December 2022 by an authorised specialist in the application and interpretation of the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), with the purpose of assessing their coordination abilities.

The inclusion criterion required that all athletes were clinically healthy. The establishment of the experimental groups and their periodization were done according to the competition calendar and the stage of preparation. The athletes were informed verbally and in writing about the purpose and methods of this study. They received a document called “Declaration of Consent”, which was agreed and signed by their legal guardians.

The results were statistically interpreted using IBM SPSS v. 12, SmartPLS and Microsoft Excel. We chose these programs for their accurate calculation of mean differences between the obtained scores but also for their interpretations of the T-test at the significance thresholds required for each subtest.

The research was conducted under the strict supervision of a certified specialist, Lecturer Bogan Gozu, and took place in three locations: “Ghencea” Water Polo Pool, “Elite” Sports Hall and “Floreasca” Water Polo Pool, all of them in Bucharest.

After analysing the test battery, we decided, together with the specialist in the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), to apply only five out of the eight subtests (the other three were considered irrelevant for the game of water polo), namely:

1. Fine motor precision (FMP)
2. Fine motor integration (FMI)

3. Bilateral coordination (BC)
4. Balance (BAL)
5. Upper limb coordination (ULC)

Pretest: Hand and foot preference

The participants must use their preferred hand or foot to perform various tasks, which is why their preferences need to be established prior to the administration of the test battery.

For hand preference, two measurements are required: one for drawing activities, and the other for activities involving ball control. First, the participant is asked to draw a line on a sheet of paper. The examiner observes which hand the participant uses and considers it the preferred hand for the drawing activities included in the first three subtests. Next, a tennis ball is placed on the table, and the participant is asked to pick it up and throw it towards the examiner, who observes which hand has been used and considers it the preferred throwing hand. Finally, to determine the preferred foot, a tennis ball is placed on floor, and the participant is asked to kick it towards the examiner. The foot used to kick the ball will be considered the participant's preferred foot for performing the various tasks of the test battery.

Description of the five subtests (Bruininks & Bruininks, 2005)

Subtest 1: Fine motor precision (FMP)

This subtest consists of activities that require precise coordination of hand and finger movement. It contains seven items that involve drawing, folding and cutting. The object of each item is to fill in shapes, draw lines through paths, connect dots, fold paper and cut within a specified boundary. Performance is measured by how well the individual manages to remain within the specified boundary. Given that the emphasis is placed on accuracy, the items are not timed.

Contents:

Items 1 and 2: Filling in shapes: circles and stars

Items 3 and 4: Drawing lines through crooked and curved paths with the preferred hand

Item 5: Connecting dots without lifting the pencil

Item 6: Folding paper

Item 7: Cutting out a circle with the preferred hand

Subtest 2: Fine motor integration (FMI)

This subtest requires the participant to reproduce drawings of various geometric shapes whose degrees of complexity range from a simple circle to overlapping pencils. The participant is asked to copy from pictures as accurately as possible. Similar to the previous subtest, the drawing tasks involve precise coordination of hand and finger movement, which is why the items are not timed. However, because the individual must reproduce a drawing without any visual aid or other guidance, this subtest also measures their ability to integrate motor control with the visual stimulus. This is known as visual-motor integration.

Visual-motor integration is commonly assessed in two ways: 1. through a multilevel approach, where all features are measured and interpreted separately; 2. through a holistic approach, where all features are simultaneously interpreted based on their comparison with a standard score. BOT-2 uses the first measurement method due to its two major advantages:

- it simplifies interpretation (the examiner acts on each feature separately and measures performance through objective criteria);
- it improves accuracy/faithfulness (all features are interpreted independently).

The only drawback of this method seems to be the increased time needed to interpret the results. However, it remains a simple and effective method because a dichotomous approach is possible for each feature. In most cases, the examiner will be able to discern the participants' results by simple visual inspection, without needing to use a ruler.

Contents:

- Item 1: Copying a circle with the preferred hand
- Item 2: Copying a square with the preferred hand
- Item 3: Copying overlapping circles with the preferred hand
- Item 4: Copying a wavy line with the preferred hand
- Item 5: Copying a triangle with the preferred hand
- Item 6: Copying a diamond with the preferred hand
- Item 7: Copying a star with the preferred hand
- Item 8: Copying overlapping pencils with the preferred hand

Subtest 3: Bilateral coordination (BC)

The items of this subtest measure the motor skills involved in playing sports and various recreational activities. The tasks require body control as well as sequential and simultaneous coordination of the upper and lower limbs. For each item, the participant performs movement sequences that are either familiar (finger pivoting, jumping jacks) or completely new to them (simultaneously tapping alternating hands and feet). When the task to be performed is unfamiliar to the participant, it is advisable for the examiner to use demonstration and the pictures presented in the test administration manual.

Contents:

- Item 1: Touching nose with index fingers – eyes closed
- Item 2: Jumping jacks (with the legs spread wide and the hands going overhead)
- Item 3: Jumping in place – same sides synchronised
- Item 4: Jumping in place – opposite sides synchronised
- Item 5: Pivoting thumbs and index fingers
- Item 6: Tapping feet and fingers – same sides synchronised
- Item 7: Tapping feet and fingers – opposite sides synchronised

Subtest 4: Balance (BAL)

This subtest assesses motor skills involved in maintaining posture when standing, walking or reaching. The tasks address the three areas that affect balance: trunk stability, postural control and using visual cues (with and without movement and sight). The items related to trunk stability include subtests such as standing on both legs, standing on one leg or standing on the balance beam. Postural control is measured by seven items for static balance and two items for dynamic balance, which requires the participant to walk forward on a line. Three of the tasks are performed with the eyes closed, which highlights the extent of the participant's dependence on visual information to maintain balance.

Contents:

- Item 1: Standing with feet apart on a line – eyes open
- Item 2: Walking forward on a line – eyes closed
- Item 3: Standing on one leg on a line – eyes open
- Item 4: Standing with feet apart on a line – eyes closed
- Item 5: Walking forward heel-to-toe on a line
- Item 6: Standing on one leg on a line – eyes closed
- Item 7: Standing on one leg on a balance beam – eyes open
- Item 8: Standing heel-to-toe on a balance beam
- Item 9: Standing on one leg on a balance beam – eyes closed

Subtest 5: Upper limb coordination (ULC)

This subtest consists of activities designed to measure the connection between visual tracking and coordinated arm and hand movement. The tasks include catching, dribbling and tossing a tennis ball to hit a target. Four of the items require using one hand, while the other three involve the coordination of both hands.

Contents:

- Item 1: Dropping and catching a ball – both hands
- Item 2: Catching a tossed ball – both hands
- Item 3: Dropping and catching a ball – one hand
- Item 4: Catching a tossed ball – one hand
- Item 5: Dribbling a ball – one hand
- Item 6: Dribbling a ball – alternating hands
- Item 7: Throwing a ball at a target

Statistical analysis

This ascertaining experiment was conducted with 61 athletes aged 10-12 years. Statistical analysis was performed using three tables (the summarised post-testing database) as follows:

✓ Table E1: Age equivalent (in years and months, for example, 11:3 – 11 years and 3 months). It reveals the difference between the athletes' chronological age (at the time of testing) and motor age. We highlight here the existence of statistically significant differences between the arithmetic means of chronological age and motor age in four of the five subtests performed, namely: fine motor integration, bilateral coordination, balance and upper limb coordination (in the case of fine motor precision the difference is not significant).

✓ Table E2: Scale score. This is a derived score that basically emphasises the concrete result (performance) achieved by each athlete in the five subtests performed. Depending on the obtained result, the participant is included in a descriptive category (Table E3). It can be noted that all data contained in these two tables are closely related. We mention that we aim to calculate the average scale scores obtained by all athletes for each of the five subtests to see in which descriptive category they would fall.

Results

Table 1 shows the descriptive category corresponding to the scale score obtained by the investigated athletes, and Table 2 shows the average scale code obtained for each subtest.

Table 1. *Descriptive category corresponding to the obtained scale score*

Descriptive category	Scale score range	Code
Well-above average	25 or over	5
Above average	20-24	4
Average	11-19	3
Below average	6-10	2
Well-below average	5 or less	1

Table 2. *Average scale code obtained for each subtest*

Score	FMP	FMI	ULC	BC	BAL
Average scores					
61	3.07	2.54	3.23	2.85	2.84

Most of the selected athletes obtained a below-average score (6-10, equivalent to code 2) in three subtests: FMI (score = 2.54), BC (score = 2.85), BAL (score = 2.84). BC and BAL values tend to get closer to the range (11-19). The athletes’ average scores for the other two subtests were: FMP = 3.07, ULC = 3.23 (scale score 11-19). In order to achieve superior performance, athletes whose scale score is 20-24 and ideally over 25 should be selected.

Fine motor precision (FMP)

Table 3 shows the athletes’ scores for the *fine motor precision* subtest.

Table 3. *Results achieved for the fine motor precision subtest*

Athletes	FMP score	Athletes	FMP score	Athletes	FMP score	Athletes	FMP score
1	15	17	14	32	12	47	14
2	12	18	14	33	17	48	13
3	14	19	18	34	12	49	14
4	17	20	10	35	16	50	17
5	11	21	12	36	18	51	17
6	17	22	12	37	16	52	17
7	12	23	14	38	15	53	17
8	17	24	15	39	13	54	18
9	14	25	12	40	12	55	14
10	14	26	16	41	21	56	14
11	12	27	13	42	17	57	21
12	18	28	12	43	17	58	17
13	15	29	16	44	14	59	14
14	22	30	15	45	21	60	17
15	19	31	12	46		61	15
16	23						

Figure 1 reveals that, for the *fine motor precision (FMP)* subtest, 90% of athletes obtained average values (score 11-19), 8% of athletes obtained above-average values (score 20-24), and 2% obtained below-average values (score 6-10).

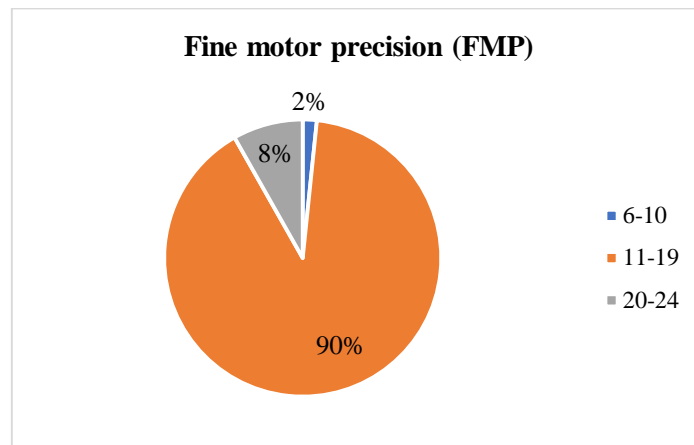


Figure 1. Graphical representation of the score percentages obtained for the *fine motor precision* subtest

To find out whether there is a statistically significant difference between the athletes' biological age and motor age measured by FMP, we apply the t-Test. The t Stat value is 1.51, which is less than the minimum accepted t Critical two-tail value (2.000298), with a very low level of significance ($p > 0.05$) and a confidence level of 95% (Table 4).

Table 4. Average score differences between Biological age and Motor age variables – FMP
Biological age (11.59) \cong FMP (11.20) - t-Test: Paired Two Sample for Means

	AGE	FMP
Mean	11.59085	11.203
Variance	2.843259	2.0557
Observations	61	61
Pearson Correlation	0.190376	
Hypothesized Mean Difference	0	
Df	60	
t Stat	1.517604	
P(T<=t) one-tail	0.067183	
t Critical one-tail	1.670649	
P(T<=t) two-tail	0.134366	
t Critical two-tail	2.000298	

We conclude that the average biological age of athletes is 11.59. This is not statistically significantly different from the motor age measured with the FMP subtest (11.20). The Statistical Inference: Test t Stat < t Critical ($p > 0.05$).

Fine motor integration (FMI)

Table 5 shows the athletes' scores for the *fine motor integration* subtest.

Table 5. Results achieved for the fine motor integration subtest

Athletes	FMI score	Athletes	FMI score	Athletes	FMI score	Athletes	FMI score
1	7	17	8	32	15	47	12
2	9	18	9	33	9	48	11
3	8	19	10	34	9	49	13
4	10	20	10	35	10	50	14
5	12	21	10	36	15	51	9
6	9	22	10	37	10	52	9
7	10	23	11	38	13	53	10
8	15	24	10	39	11	54	11
9	8	25	13	40	10	55	15
10	12	26	10	41	8	56	15
11	10	27	13	42	10	57	18
12	9	28	11	43	12	58	22
13	12	29	12	44	12	59	10
14	13	30	12	45	18	60	12
15	9	31	12	46	22	61	15
16	7						

Figure 2 reveals that, for the *fine motor integration (FMI)* subtest, 48% of athletes obtained average values (score 11-19), 49% of athletes obtained below-average values (score 6-10), and 3% obtained above-average values (score 20-24).

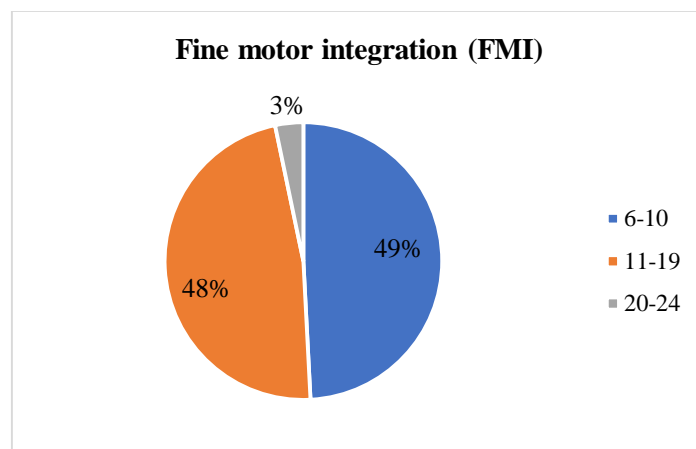


Figure 2. Graphical representation of the score percentages obtained for the *fine motor integration* subtest

To find out whether there is a statistically significant difference between the athletes' biological age and motor age measured by FMI, we apply the T-test. The t Stat value is 8.26 and is therefore greater than the minimum accepted t Critical two-tail value (2.000298), with a very high level of significance ($p < 0.05$) and a confidence level of 95% (Table 6).

Table 6. Average score differences between Biological age and Motor age variables – FMI Biological age (11.59) > FMI (9.34)

	AGE	FMI
Mean	11.59085	9.344262
Variance	2.843259	2.730508
Observations	61	61
Pearson Correlation	0.192063	
Hypothesized Mean Difference	0	
Df	60	
t Stat	8.268258	
P(T<=t) one-tail	8.55E-12	
t Critical one-tail	1.670649	
P(T<=t) two-tail	1.71E-11	
t Critical two-tail	2.000298	

We conclude that the average biological age of athletes is 11.59. This is statistically significantly different from the motor age measured with the FMI subtest (9.34). The Statistical Inference Test: $t \text{ Stat} > t \text{ Critical}$ ($p < 0.05$).

Bilateral coordination (BC)

The athletes' scores for the *bilateral coordination* subtest are shown in Table 7.

Table 7. Results achieved for the bilateral coordination subtest

Athletes	BC score	Athletes	BC score	Athletes	BC score	Athletes	BC score
1	11	17	10	32	10	47	15
2	9	18	11	33	13	48	10
3	13	19	13	34	8	49	11
4	15	20	13	35	13	50	13
5	9	21	9	36	13	51	13
6	13	22	11	37	16	52	13
7	13	23	10	38	13	53	15
8	13	24	11	39	13	54	16
9	13	25	11	40	16	55	13
10	13	26	11	41	13	56	13
11	12	27	13	42	13	57	15
12	11	28	11	43	13	58	15
13	13	29	10	44	13	59	15
14	13	30	11	45	15	60	15
15	11	31	13	46	15	61	16
16	11						

Figure 3 reveals that, for the *bilateral coordination (BC)* subtest, 85% of athletes obtained average values (score 11-19), and 15% obtained below-average values (score 6-10).

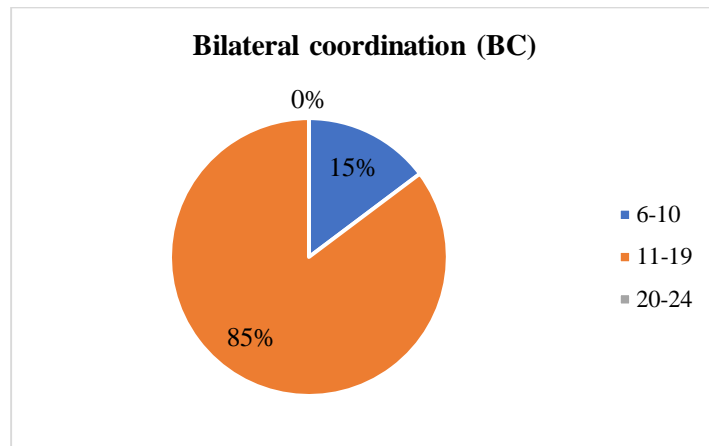


Figure 3. Graphical representation of the score percentages obtained for the *bilateral coordination* subtest

To find out whether there is a statistically significant difference between the athletes' biological age and motor age measured by BC, we apply the t-Test. The t Stat value is 11.71 and is therefore greater than the minimum accepted t Critical two-tail value (2.000298), with a very high level of significance ($p < 0.05$) and a confidence level of 95% (Table 8).

Table 8. Average score differences between Biological age and Motor age variables – BC
 Biological age (11.59) < BC Motor age (9.11)

	AGE	BC
Mean	11.59085	9.118033
Variance	2.843259	0.608836
Observations	61	61
Pearson Correlation	0.27858	
Hypothesized Mean Difference	0	
Df	60	
t Stat	11.71248	
P(T<=t) one-tail	1.92E-17	
t Critical one-tail	1.670649	
P(T<=t) two-tail	3.85E-17	
t Critical two-tail	2.000298	

We conclude that the average biological age of athletes is 11.59. This is statistically significantly different from the motor age measured with the BC subtest (9.11). The Statistical Inference Test: $t \text{ Stat} > t \text{ Critical}$ ($p < 0.05$).

Balance (BAL)

Table 9 shows the athletes' scores for the *balance* subtest.

Table 9. Results achieved for the balance subtest

Athletes	BAL score	Athletes	BAL score	Athletes	BAL score	Athletes	BAL score
1	9	17	13	32	10	47	20
2	13	18	13	33	12	48	13
3	12	19	12	34	13	49	13
4	8	20	6	35	13	50	13
5	9	21	13	36	8	51	12
6	12	22	13	37	11	52	12
7	15	23	13	38	12	53	15
8	7	24	16	39	12	54	16
9	8	25	16	40	11	55	13
10	12	26	13	41	12	56	13
11	6	27	12	42	13	57	15
12	12	28	16	43	13	58	17
13	8	29	17	44	15	59	12
14	13	30	14	45	17	60	17
15	9	31	13	46	17	61	16
16	11						

Figure 4 reveals that, for the *balance* (BAL) subtest, 80% of athletes obtained average values (score 11-19), 18% of athletes obtained below-average values (score 6-10), and 2% obtained above-average values (score 20-24).

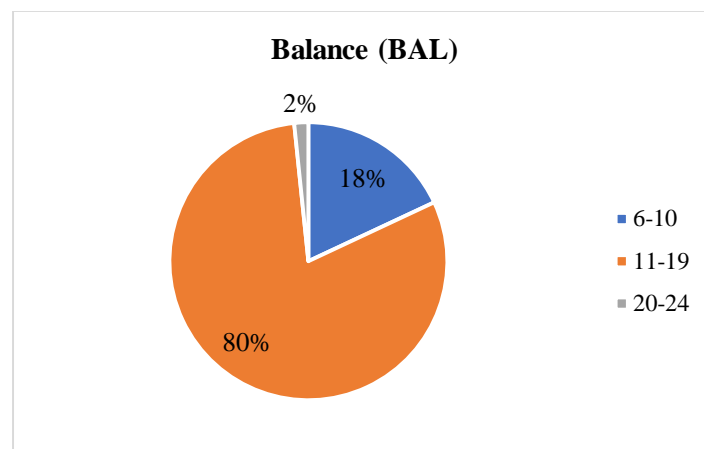


Figure 4. Graphical representation of the score percentages obtained for the *balance* subtest

To find out whether there is a statistically significant difference between the athletes' biological age and motor age measured by BAL, we apply the t-Test. The t Stat value is 7.28 and is therefore greater than the minimum accepted t Critical two-tail value (2.000297), with a very high level of significance ($p < 0.05$) and a confidence level of 95% (Table 10).

Table 10. Average score differences between Biological age and Motor age variables – BAL
Biological age (11.59) < BAL (8.66)

	AGE	BAL
Mean	11.59084699	8.662295082
Variance	2.843258576	8.943387978
Observations	61	61
Pearson Correlation	0.191851494	
Hypothesized Mean Difference	0	
Df	60	
t Stat	7.287202257	
P (T<=t) one-tail	4.04469E-10	
t Critical one-tail	1.670648865	
P (T<=t) two-tail	8.08939E-10	
t Critical two-tail	2.000297822	

We conclude that the average biological age of athletes is 11.59. This is statistically significantly different from the motor age measured with the BAL subtest (8.66). The Statistical Inference Test: $t \text{ Stat} > t \text{ Critical}$ ($p < 0.05$).

Upper limb coordination (ULC)

Table 11 shows the athletes' scores for the *upper limb coordination* subtest.

Table 11. Results achieved for the *upper limb coordination* subtest

Athletes	ULC score	Athletes	ULC score	Athletes	ULC score	Athletes	ULC score
1	19	17	22	32	15	47	18
2	22	18	14	33	18	48	19
3	12	19	19	34	22	49	19
4	13	20	16	35	14	50	18
5	13	21	22	36	12	51	18
6	18	22	19	37	14	52	18
7	22	23	16	38	16	53	18
8	11	24	19	39	12	54	16
9	18	25	19	40	12	55	15
10	15	26	19	41	18	56	18
11	20	27	22	42	22	57	22
12	16	28	16	43	18	58	22
13	14	29	20	44	18	59	18
14	16	30	23	45	22	60	15
15	17	31	18	46	22	61	19
16	17						

Figure 5 reveals that, for the *upper limb coordination (ULC)* subtest, 77% of athletes obtained average values (score 11-19), and 23% obtained above-average values (score 20- 24).

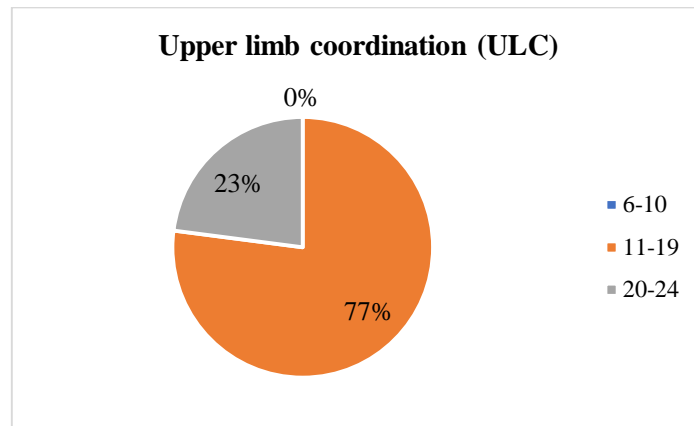


Figure 5. Graphical representation of the score percentages obtained for the *upper limb coordination* subtest

To find out whether there is a statistically significant difference between the athletes’ biological age and motor age measured by ULC, we apply the t-Test. The t Stat value is 3.89 (in the mode) and is therefore greater than the minimum accepted t Critical two-tail value (2.0003), with a very high level of significance ($p < 0.05$) and a confidence level of 95% (Table 12).

Table 12. Average score differences between Biological age and Motor age variables – ULC Biological age (11.59) < ULC (12.96)

	AGE	ULC
Mean	11.5908	12.9656
Variance	2.84326	6.12796
Observations	61	61
Pearson Correlation	0.16656	
Hypothesized Mean Difference	0	
Df	60	
t Stat	-3.8997	
P(T<=t) one-tail	0.00012	
t Critical one-tail	1.67065	
P(T<=t) two-tail	0.00025	
t Critical two-tail	2.0003	

We conclude that the average biological age of athletes is 11.59. This is statistically significantly different from the motor age measured with the ULC subtest (12.96). The Statistical Inference Test: $t \text{ Stat} > t \text{ Critical}$ ($p < 0.05$).

Discussion

According to water polo specialists (Marinescu et al., 2018), “general and specific land training is particularly important for children and juniors to increase their water-specific motor skills” (p. 51). Testing provides valuable information about the water sports performance and training level of young players. Marinescu et al. (2020) also applied the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2) to top-elite athletes who were in the focus

of the national team. Considering the context and the specifics of this sports discipline but especially the fact these tests should be performed and implemented in the training process at juvenile age (10-12 years of age), we mention the following aspects:

- ✓ The average biological age of athletes is 11.59. This is not statistically significantly different from the motor age measured with the FMP subtest (11.20).
- ✓ The average biological age of athletes is statistically significantly different from the motor age measured with the FMI subtest (9.34).
- ✓ The average biological age of athletes is statistically significantly different from the motor age measured with the BC subtest (9.11).
- ✓ The average biological age of athletes is statistically significantly different from the motor age measured with the BAL subtest (8.66).
- ✓ The average biological age of athletes is statistically significantly different from the motor age measured with the ULC subtest (12.96).
- ✓ Most of the selected athletes obtained a below-average score (6-10, equivalent to code 2) in three subtests: FMI (score = 2.54), BC (score = 2.85), BAL (score = 2.84). BC and BAL values tend to get closer to the range (11-19).
- ✓ The athletes' average scores for the other two subtests were: FMP = 3.07, ULC = 3.23 (scale score 11-19). In order to achieve superior performance, athletes whose scale score is 20-24 should be selected; another option would be to implement exercises for the development of coordination abilities in the specific training of athletes.
- ✓ In the BC subtest, 85% obtained average values (score 11-19), and 15% below-average values (score 6-10).
- ✓ In the BAL subtest, 80% obtained average values (score 11-19), and 2% above-average values (score 20-24).
- ✓ In the ULC subtest, 77% obtained average values (score 11-19), and 23% above-average values (score 20-24).

The tests addressed to measure coordinative abilities can be, also, used in the selection process in the game of water polo, at the age of 10-12 years old.

Data from specialised studies “contribute to an increased knowledge on a multivariate approach of youth team players in general and adolescent water polo players in particular” (Noronha et al., 2022). This fact attaches particular importance to the present research, given the complexity of this sports discipline and the relevance of implementing exercises for the development of coordination abilities in the specific training of juvenile athletes.

Conclusion

As a result of applying the Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2), the following conclusions can be drawn from this study:

1. The level of manifestation of coordination abilities can be established in athletes aged 10-12 (being presented within the paper).
2. The athletes participating in this study have (generally) an average or below-average level in the case of tested coordination abilities.

3. It has been confirmed that testing the athletes' coordination abilities is very important, and the implementation of exercises aimed at developing the components of these abilities in the training process is imperative.

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Informed Consent Statement: The written informed consent for the participants in this study was obtained.

Data Availability Statement: Data are available upon request to the contact author.

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References

- Bălan, V., Marinescu, G., Ticală, L., & Shaao, M. (2012). Physical education - Lifelong learning factor. *Procedia - Social and Behavioral Sciences*, 46, 1328-1332.
<https://doi.org/10.1016/j.sbspro.2012.05.296>
- Bellis, M. (2021). *A brief history of sports*. <https://www.thoughtco.com/history-of-sports-1992447>
- Bruininks R. H. (1978). *Bruininks-Oseretsky Test of Motor Proficiency*. Circle Pines.
- Bruininks, R. H., & Bruininks, B. D. (2005). *BOT-2 - Bruininks-Oseretsky Test of Motor Proficiency, Second Edition, Complete Form Report*. NCS Pearson.
- Canossa, S., Fernandes, R. J., Estriga, L., Abraldes, J. A., Lupo, C., & Garganta, J. M. (2022). Water polo offensive methods after the 2018 FINA rules update. *International Journal of Environmental Research and Public Health*, 19(5): 2568.
<https://doi.org/10.3390/ijerph19052568>
- Collegiate Water Polo Association. (n.d.). *History of the game of water polo*.
<https://collegiatewaterpolo.org/fans/gameinfo/history/>
- Deitz, J. C., Kartin, D., & Kopp, K. (2007). Review of the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2). *Physical & Occupational Therapy in Pediatrics*, 27(4), 87-102.
https://doi.org/10.1080/J006v27n04_06
- Duger, T., Bumin, G., Uyanik, M., Aki, E., & Kayihan, H. (1999). The assessment of Bruininks-Oseretsky Test of Motor Proficiency in children. *Pediatric Rehabilitation*, 3(3), 125-131.
<https://doi.org/10.1080/136384999289531>

- Hattie, J., & Edwards, H. (1987). A review of the Bruininks-Oseretsky Test of Motor Proficiency. *British Journal of Educational Psychology*, 57(1), 104-113.
<https://doi.org/10.1111/j.2044-8279.1987.tb03065.x>
- Marinescu, G., Ticală, L. D., Hoanță, D., Rădulescu, A., Danciu, R., & Alogaili, W. (2018). Aspects of psychomotricity in water polo players – juniors aged 14-15. *Discobolul – Physical Education, Sports and Kinetotherapy Journal*, 4(54), 46-51.
- Marinescu, G., Ticală, L. D., Rădulescu, A., Vărzaru, C., Mujea, A. M., & Kkidir, E. D. S. (2020). Aspects regarding strength and agility in junior III water polo players. *Discobolul – Physical Education, Sports and Kinetotherapy Journal*, 59(4), 460-471.
<https://doi.org/10.35189/dpeskj.2020.59.4.11>
- Moanță, A. D., Tudor, V., & Ghițescu, I. G. (2013). The methodological overview for the technical-tactical training in basketball. *Procedia - Social and Behavioral Sciences*, 93, 2173-2179. <https://doi.org/10.1016/j.sbspro.2013.10.183>
- Noronha, F., Canossa, S., Vilas-Boas, J. P., Afonso, J., Castro, F., & Fernandes, R. J. (2022). Youth water polo performance determinants: The INEX Study. *International Journal of Environmental Research and Public Health*, 19(9): 4938.
<https://doi.org/10.3390/ijerph19094938>
- Tudor, V., Pelin, F., Ghițescu, G. I., Ciolcă, C., Ciolcă, S., Badea, D., Ticală, L. D., Stoicescu, M., Mujea, A.-M., Ursu, E., Ciobanu, M., & Hondru, C. I. (2022). Biomotor profile of children at risk of educational and social exclusion in North-Eastern Romania. *Discobolul – Physical Education, Sports and Kinetotherapy Journal*, 61(1), 15-28.
<https://doi.org/10.35189/dpeskj.2022.61.1.2>
- Țifrea, C., Cristian, V., & Mănescu, D. (2015). Improving fitness through bodybuilding workouts. *Social Sciences*, 4(1), 177-182.
<http://dx.doi.org/10.18662/lumenss.2015.0401.16>
- Vasile, L. (2014). Endurance training in performance swimming. *Procedia - Social and Behavioral Sciences*, 117, 232-237. <https://doi.org/10.1016/j.sbspro.2014.02.206>
- Wilson, B. N., Polatajko, H. J., Kaplan, B. J., & Faris, P. (1995). Use of the Bruininks-Oseretsky Test of Motor Proficiency in occupational therapy. *The American Journal of Occupational Therapy*, 49(1), 8-17. <https://doi.org/10.5014/ajot.49.1.8>