International Journal of Human Movement and Sports Sciences 9(5): 940-947, 2021 http://www.hrpub.org
DOI: 10.13189/saj.2021.090515

Improving Coordination of Young Footballers Aged 9-10 Years

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Received June 4, 2021; Revised July 26, 2021; Accepted August 22, 2021

Cite This Paper in the following Citation Styles

(a): *[1] Sergey H. Sobko, Natalia H. Sobko, Tatiana V. Maleniuk, Victoria A. Babalich, Halyna I. Panchenko , "Improving Coordination of Young Footballers Aged 9-10 Years," International Journal of Human Movement and Sports Sciences, Vol. 9, No. 5, pp. 940 - 947, 2021. DOI: 10.13189/saj.2021.090515.*

(b): *Sergey H. Sobko, Natalia H. Sobko, Tatiana V. Maleniuk, Victoria A. Babalich, Halyna I. Panchenko (2021). Improving Coordination of Young Footballers Aged 9-10 Years. International Journal of Human Movement and Sports Sciences, 9(5), 940 - 947. DOI: 10.13189/saj.2021.090515.*

Abstract The purpose of the study was to examine how the upgraded system of training based on 12 exercises for the development of coordination abilities influenced the coordination of young footballers aged 9-10 years. The quantitative and qualitative methods were used to collect data in the study. The study used the quasi-experimental design that was based on the pretest-posttest measurements accompanied by observations. The experiment involved only one group and the results of the students before and after the intervention were compared. The study proved that the upgraded system of training based on 12 exercises for the development of coordination abilities influenced the coordination of young footballers aged 9-10 years. The system of training also improved the students' abilities to adjust and adapt motor actions; kinaesthetic differentiation of movements (ball sensation). The overall improvement was approximately 21% which was statically significant. The students were found to have improved in the seven coordination abilities. It was also found that there was shift in students' level of coordination from 'low' to 'average' and 'above'.

Keywords Young Footballers, Coordination, Age of 9-10 Years, Motor Actions, Kinaesthetic Differentiation of Movements

1. Introduction

Good coordination abilities are of key importance for a footballer as the game requires a player to perform quickly and purposefully spatiotemporal movements which involve the use of all motor abilities in constantly changing situations [1–3]. Coordination abilities are the functional capabilities of certain organs and structures of the body, the interaction of which determines the coherence of individual elements of movement into a single motor action. Coordination activity undergoes major changes in ontogenesis, and they have their characteristics in different age groups [4, 5]. According to the Dynamic Systems Theory of development, it is optimum for 9-10-year-old football players to develop and improve coordination as this period of their development is associated with a steady growth of their large muscle development, along with strength, balance, and coordination [6, 7]. This age period is characterised by an active, uniform development of coordination abilities, which is attributed to the natural growth of the child and the corresponding development of the systems and functions of his body. Motor coordination skills are most actively formed at the age of 7-11 years [8, 9]. It is proven that the process of forming coordination movements is quite complex in its composition for both children and the coach since it requires special concentration, and vigilance [10]. Most often, children perform such exercises without much interest and desire, because the movements require

a lot of effort, labour, and will [11]. Therefore, to increase the level of coordination abilities in children of school age, this work should be carried out systematically, and adequate means should be selected.

The review of the relevant literature on the problem of developing coordination abilities found that there is still no unanimity in methodological views across scientists and practitioners. According to [12–15], there are seven coordination abilities of the most significance. These are the ability to rearrange and adapt motor actions, kinaesthetic differentiation of movements (ball sensation), sense of the rhythm of movements, the ability to coordinate movements, orientation in space, speed of motor reaction, balance (in dynamic and static conditions). Though this categorisation seems arguable for the authors of the study in the context of the football games, they tend to agree that there are two coordination abilities of special importance such as the ability to adjust and adapt motor actions and kinesthetic differentiation of movements (ball sensation). In this study, the coordination abilities will be referred to as a condition for optimal control and regulation of motor actions, adequate adaptation to external conditions, as well as speed, stability, and accuracy in learning movements [2]. Since the models of young footballers' training are constantly improving and changing and the practitioners are looking for ways and alternatives to improve the effectiveness of a player, this created a gap that was addressed through implementing the training model based on 12 specifically arranged exercises.

Therefore, the purpose of the study was to examine how the upgraded system of training based on 12 exercises for the development of coordination abilities influenced the coordination of young footballers aged 9-10 years.

2. Methods and Materials

The quantitative and qualitative methods of data collection were used in the study [16]. The quantitative data were yielded from Bruininks–Oseretsky Test of Motor Proficiency-2 [17], McCarron Assessment of Neuromuscular Development [18], Movement Assessment Battery for Children-2 [19], Tufts Assessment of Motor Performance [20] and the Zurich Neuromotor Assessment [21]. The qualitative data were drawn from observations. The Bruininks–Oseretsky Test of Motor Proficiency-2 was supposed to evaluate the students' abilities of manual control, manual coordination, body coordination, strength, and agility. The McCarron Assessment of Neuromuscular Development was used to measure a range of gross and fine motor skills. The Movement Assessment Battery for Children-2 was applied to measure students' manual dexterity, aiming, catching, and balance. The Tufts Assessment of Motor Performance test was applied to assess such abilities as 'grasp and release', 'fasteners', 'manipulation', 'typing', 'balance', 'mat mobility', and 'ambulation'. The Zurich Neuromotor Assessment was used to measure the students' neuromotor development before and after the treatment. Overall, the tests measured the sampled students' coordination abilities such as restructuring and adaptation of motor actions identified through evaluating the students' abilities to run around the racks and driving the ball, hit the ball to target to assess the kinesthetic differentiation of movements ("ball sensation"). The results obtained from the intervention of the study were processed using mathematical statistics methods based on the statistical values such as weighted arithmetic mean (m), mean square deviation (σ), the error of the arithmetic mean (m), coefficient of variation (v,%). Assessment of the level of coordination abilities of young football players aged 9-10 years was carried out on a Gaussian Curve according to the three-sigma rule, which is separately developed by us for each test; individual and average group values were determined. To improve the level of development of coordination abilities of young football players, a set of tools was developed and implemented in the educational and training process, which was based on relay races with a ball with the difficulty of passing the distance. For more effective development of coordination abilities, special equipment was used: ladders, cones, racks, rings, barriers 15 cm high, trampolines for children, gymnastic mats, "hedgehogs", gymnastic benches, chips, small football Gates, hemispheres. By using this equipment, an additional complication was introduced such as barriers required the performer of the exercise to raise his legs higher, gymnastic benches – to focus more on balancing during its passage, ladders – to move his legs faster to get into each square, racks – to perform a slalom run. And this is only a small number of possible options for using the specified inventory.

The study used the quasi-experimental design that was based on the pretest-posttest measurements accompanied by observations [22, 23]. The experiment involved only one group. The results of the students before and after the intervention were compared..

2.1. Description of the Intervention

The complex consisted of 12 relay exercises performed in a four-week cycle of training sessions during the school year. Classes were held 3 times a week. The suggested exercises were performed for 25 minutes of the main part of the training session (two sets of 4 repetitions each). The number of repetitions and series of the below activities were specified to comply with the requirements of [3] who proved that the number of repetitions of coordination exercises should be 4-40 (in most cases from 4 to 12 times), and the number of series – from 1 to 6. Below are outlined the exercises and the descriptions.

Exercise # 1: performed in 2 lines. In front of the lines,

there are 4 posts (at a distance of 10m placed after each other at a distance of 1m), then there is 1 barrier (between the barrier and the last post a distance of 2m), then there is a small gate (at a distance of 5m from the barrier). The child starts at the signal from the chip at the beginning of the exercise, the movement is performed straight forward, it is necessary to cover a distance of 10 m by driving the ball with your feet, then take the ball in your hands, run around 4 racks, then jump over the barrier, put the ball in your feet and score a goal with your foot in a small goal. After the goal, the one takes the ball in their hands and returns to the end of the line.

Exercise # 2: performed in 2 lines. In front of the lines, there is a ladder (at a distance of 50 cm from the start), 4 cones (placed at a distance of 60 cm from each other, between the first cone and the ladder a distance of 2 M), then a small gate is located (at a distance of 5 m from the cones). The child starts at the signal from the chip at the beginning of the exercise, the movement is performed straight forward, overcome the ladder by jumping into each square on two legs (legs together), after overcoming the ladder, the coach rolls the ball into the child's feet, then the four cones are beaten with his feet, after overcoming the cones, score a goal in a small football goal. After the goal, the one takes the ball in your hands and returns to the end of the line.

Exercise # 3: performed in 2 lines. In front of the columns, there is a Hemisphere (immediately at the start), there is a barrier near it, then 4 rings are located at a distance of 2M, after the rings at a distance of 2 M 3 racks (arranged in a zigzag at an angle of 45 °, right and left at a distance of 1m from each other), then there are small gates (at a distance of 5m from the racks). The students are supposed to jump 1 barrier 15 cm high, then overcome 4 rings, entering 1 foot in one ring, then run around 3 racks that are arranged in a zigzag pattern at an angle of 45 ° from each other to the right and left, then score the ball into the goal, standing in front of a small football goal at a distance of 5 M. After the goal, the one takes the ball in their hands and returns to the end of the line.

Exercise #4: performed in 2 lines. In front of the columns, there are 4 racks (between which the distance is 1m, the distance between the first rack and the start is 2m), a gymnastic bench (at a distance of 2m from the last rack), a small gate (at a distance of 5m from the gymnastic bench). The child starts at the signal, the movement is performed straight forward, beat 4 racks with driving the ball with your feet, then take the ball in your hands, balancing, walk on the gymnastic bench, after the gymnastic bench, put the ball back in your feet and score it into a small football goal. After the goal, the one takes the ball in their hands and returns to the end of the line.

Exercise #5: performed in 2 lines. In front of the lines, columns there is a cone (at a distance of 2 m from the beginning of the exercise), a gym mat (at a distance of 2 m from the cone), 4 chips (between which the distance is 50 cm, the first of them is at a distance of 3 m from the gym mat), a small gate (at a distance of 5 m from the last of the four chips). The child starts at the signal from the chip, the movement is performed straight forward, run around the cone at 3600, perform a somersault forward on the gymnastic mat, after overcoming the gymnastic mat, the coach rolls the ball into the child's feet, then perform a beating of 4 chips by driving the ball with his feet and score the ball into a small football goal standing at a distance of 5 m from the chips. After the goal, the one takes the ball in their hands and returns to the end of the line.

Exercise #6: performed in 2 lines. In front of the columns are located: a gymnastic trampoline for children (at a distance of 1m from the beginning of the exercise), a gymnastic mat (which lies close to the trampoline), 4 racks (between which the distance is 1m, the first rack is at a distance of 2m from the gymnastic mat), a small football goal at a distance of 5m from the last rack. The beginning of the exercise is performed on a trampoline with a ball in your hands. At the signal, you need to throw the ball to the coach, perform 5 jumps up without the ball, the sixth is performed forward on the gym mat with a landing on your feet, then perform a forward somersault, then get the ball from the coach, put it in your feet, perform a beating of 4 racks and score a goal in a small football goal. After the goal, the one takes the ball in their hands and returns to the end of the line.

Exercise #7: performed in 2 lines. In front of the columns there are 4 racks (at a distance of 1m from each other, the distance between the beginning of the exercise and the rack is 2m), after the racks perpendicular to them are 3 chips (red, blue, and yellow colours at a distance of 50 cm from each other) at a distance of 3m. On the chips there is 1 ball, at the end – a small football goal located at a distance of 5m from the chips. At the signal, the coach names one of the three colours of chips, and the start is performed. The student is expected to overcome 4 racks, take the ball from the chip of the same colour that the coach called, bring it to the small football goal and score a goal with their foot. After the goal, the one takes the ball in their hands and returns to the end of the line.

Exercise #8: performed in 2 lines. In front of the lines, there are 3 barriers (the distance between which is 50 cm, the first barrier is located 1 m from the beginning of the exercise), 5 rings (arranged in a zigzag pattern next to each other at a distance of 2 m from the barriers), 3 racks (placed at a distance of 1 m from each other, between the first rack and the last ring a distance of 2 M), then at a distance of 5 M small football Gates. At the signal, the one should start with a chip, jump over 3 barriers on two legs (legs together), then run 5 rings (each leg in a separate ring), get the ball from the coach, beat 3 racks by driving the ball with your feet and score a goal in a small

football goal, after the goal, the one should take the ball in their hands and return to the end of the line.

Exercise #9: performed in 2 lines. In front of the lines there are 5 rings at a distance of 1m from the start, 3 barriers (between which the distance is 40cm, between the last ring and the first barrier the distance is 2m), 4 "hedgehogs" (between which the distance is 15cm, the distance between the last barrier and the first "hedgehog" is 2m), a small football goal (at a distance of 5m from the "hedgehogs"). At the signal, the one should start with a chip, run 5 rings with the ball in your hands (each foot into the next ring), jump 3 barriers on two legs (legs together), pass through the "hedgehogs" (each footstep on the next "hedgehog"), hold the ball between their feet, hold and score a goal in a small football goal. After the goal, they should take the ball in their hands and return to the end of the line.

Exercise # 10: performed in 2 lines. In front of the line are: a ladder (at a distance of 1 m from the beginning of the exercise), 3 barriers (at a distance of 1 m from the ladder, between which 40 cm, placed at an angle of 45 ° to the Left), 4 rings (at a distance of 1 m from the barriers, at an angle of 90 ° relative to them) Plank (made of 2 large cones and racks, placed at a distance of 2 m at an angle of 45 ° to the left relative to the rings), a small football goal (at a distance of 5 m from the bar). At the signal, with the ball in their hands, the one should run a ladder (each leg in a separate square), then jump on two legs over barriers (legs together), run 4 circles, crawl under the bar, put the ball in your feet, hold it to the goal, score a goal. After the goal, the one should take the ball in their hands and return to the end of the line.

Exercise # 11: performed in 2 lines. In front of the lines there are 3 barriers (at a distance of 1m from the beginning of the exercise), a small football goal (at a distance of 2m from the last barrier, facing forward), a soccer ball in front of the goal (at a distance of 1m from the goal), 3 racks (at a distance of 2m from the ball), chips (randomly located, at a distance of 3m from the last rack). At the signal, the students should perform jumps on two legs over barriers (legs together), score the ball with their foot standing in front of a small football goal, run around 3 racks, take a chip at the end of the race, and return with the chip to their line as soon as possible, placing it next to it.

Exercise #12: performed in 2 lines. In front of the columns there is 1 rack (at a distance of 2 m from the beginning of the exercise), 3 barriers (at a distance of 2 m from the rack, a distance of 40 cm between the barriers), 1 rack (2 m from the last barrier), 3 cones (2 m from the rack), 1 rack (2 m from the last cone). At the signal with the ball in their hands, the one should run around the rack 360 °, run through the barriers, run around the rack 360 ° again, put the ball in your feet, Circle 3 cones, circle the last rack 360 °, and cover the entire distance before the exercise starts in the opposite direction, performing the entire sequence in reverse. Pass the baton to the next participant.

2.2. Sampling

Convenience sampling [24] was used to form the experimental group of 43 students who were trained at the Youth Sports School "Academy of FC Zvezda" in Kropyvnytskyi, Ukraine, during the 2018-2019 academic year. The sampled students were hired according to their age - young football players were supposed to be born in 2008-2009. The dispersion of results in the group for the indicator of the ability to adjust and adapt motor actions is on average 15.4%, the indicator of kinaesthetic differentiation of movements (ball sensation) – 69.52%, which indicates the heterogeneity of fitness of young football players, especially concerning the latter indicator.

2.3. Instruments

There were five tests used as the quantitative instruments in the study. These were as follows: Bruininks–Oseretsky Test of Motor Proficiency (BOT-2), McCarron Assessment of Neuromuscular Development (MAND), Movement Assessment Battery for Children (Movement ABC-2), Tufts Assessment of Motor Performance (TAMP), and Zurich Neuromotor Assessment (ZNA). The observation reports were qualitative instruments. The SPSS Statistics software package was used to process consolidated data.

Bruininks–Oseretsky Test of Motor Proficiency (BOT-2)

The test-retest reliability values are r = .84 for 4–7 year-olds, r = 0.85 for 8–12 year-olds and r = 0.75 for 13–21 years. Internal consistency for a = 0.95–96. Concurrent validity for BOTMP is r = 0.76, r = 0.77 for the Peabody Developmental Motor Scales and r = 0.62 for the Test of Visual Motor Skills.

McCarron Assessment of Neuromuscular Development (MAND)

The tool is valid if the values for r = .98 for fine motor, r = .96 for gross motor and r = .99 for the whole test. The reference values for the test are as follows: r = A.48 for the Simple reaction time, r = A.58 for the choice reaction time, r = .39 for the haptic visual discrimination test, and r = A.33 for the Bender Visual-Motor Gestalt Test.

Movement Assessment Battery for Children-2 (MABC-2)

It was found valid as Item ICCs were 0.62–0.92.

Tufts Assessment of Motor Performance (TAMP)

A value that is higher than 0.85 is considered a good ICC index.

Zurich Neuromotor Assessment (ZURICH)

Reference values for visuomotor functions of the tool vary between r = 0.35–0.39.

The observation reports were consolidated and analysed manually. The coding of the judgements was performed.

3. Results

Pretest and posttest measurements were carried out to identify the change in coordination abilities of young football players and carried out mathematical and statistical processing of its results. The progressive dynamics of shifts in indicators during the study are traced (Table 1), which allowed us to identify whether the above set of exercises was effective.

The reliability of differences in the results was determined using the student's t-criterion at $P<0.05$. Thus, significant differences during the study period are noted for most tests of the indicator "ability to adjust and adapt motor actions" at $P<0.05$. At the same time, there are no significant differences in the test "running with running around racks and driving the ball with an uneducated foot" and all tests of the indicator "kinaesthetic differentiation of movements (ball sensation)" ($P>0.05$).

As can be seen in Table 1, the sampled students experienced an improvement in their ability to adjust and adapt motor actions and kinaesthetic differentiation of movements (ball sensation). The overall improvement is approximately 21% which is statically significant. The above agrees with the authors' opinion. The first reason is special properties of the vestibular apparatus and nervous system of children of this age, and the second is that [14] emphasises that between the age of 7 and 9 years old, you cannot force a child to perform certain technical actions with a "weak" leg, except for the case where the child does it arbitrarily, due to his/her characteristics." The use of this indicator is justified by the fact that in the practice of sports training, especially at low stages of sports skills, scientists recommend focusing on the development of all seven coordination abilities, because in experimental studies of the authors, the possibility of compensating for the insufficient level of development of some coordination abilities at the expense of the development of others has been established.

The levels of manifestation of children's coordination abilities presented in Table 2 are re-determined.

Table 1. Dynamics of coordination ability indicators young football players aged 9-10 years during the study

#	Indicators	Testing		
		Before intervention	After intervention	P
		$\frac{M \pm \sigma}{m, V}$		
	ability to adjust and adapt motor actions			
1.	Running with running around the racks in the opposite direction, s	8,9 ±0,75 0,18; 8,43	8,29 ±0,68 0,17; 8,30	<0,05
2.	Running with running around the racks in the leading direction, s	8,93 ±0,57 0,14; 6,38	8,47 ±0,55 0,13; 6,24	<0,05
3.	Running with running around the racks and driving the ball with an uneducated foot, s	15,05 ±1,75 0,42; 11,63	13,97 ±1,58 0,39; 10,78	>0,05
4.	Running with running around the racks and driving the ball with the leading foot, s	14,21 ±1,5 0,36; 10,56	13,25 ±1,5 0,31; 10,50	<0,05
5.	Time difference between Test 1 and 3, s	5,79 ±1,4 0,33; 24,18	4,88 ±1,36 0,31; 23,70	<0,05
6.	Time difference between Test 2 and 4, s	5,33 ±1,66 0,4; 31,14	4,24 ±1,58 0,38; 29,70	<0,05
	kinesthetic differentiation of movements (ball sensation)			
1.	Hitting the ball with the leading foot on the target, points	5,16 ±3,93 0,79; 76,16	6,47 ±3,66 0,77; 71,73	>0,05
2.	Hitting the ball with an uneducated foot on the target, points	4,22 ±3,66 0,73; 86,73	5,51 ±3,03 0,72; 78,83	>0,05
3.	Sum of hits on the ball with the leading and non-leading foot on the target, points	8,32 ±3,8 0,76; 45,67	9,69 ±3,43 0,74; 41,47	>0,05

Table 2. Levels of manifestation of coordination abilities of young football players

№	Test (indicator)	Levels (%)									
		high		above average		average		lower for the average		low	
		start	end	start	end	start	end	start	end	start	end
ability to adjust and adapt motor actions											
1.	Running with running around the racks in the opposite direction, s	-	-	4.65	65.12	83.72	23.25	-	11.63	11.63	-
2.	Running with running around the racks in the leading direction, s	-	-	4.65	76.75	72.1	1.,60	18,6	4.65	4.65	-
3.	Running with running around the racks and driving the ball with an uneducated foot, s	-	4.65	23.26	34.89	76.74	60.46	-	-	-	-
4.	Running with running around the racks and driving the ball with the leading foot, s	-	23.26	25.58	25.58	51.16	51.16	23.26	-	-	-
5.	Time difference between Test 1 and 3, s	-	11.64	11.63	4.18	60.46	44.18	27.91	-	-	-
6.	Time difference between Test 2 and 5, s	4.65	18.60	11.63	25.58	60.46	55.82	23.26	-	-	-
kinesthetic differentiation of movements (ball sensation)											
1.	Hitting the ball with the leading foot on the target, points	-	6.98	6.98	44.19	81.4	48.83	11.62	-	-	-
2.	Hitting the ball with an uneducated foot on the target, points	4.65	16.28	16.28	16.28	67.44	67.44	11.63	-	-	-
3.	Sum of hits on the ball with the leading and non-leading foot on the target, points	4.65	16.28	11.63	39.53	65.12	44.19	18.60	-	-	-

The analysis of the results in Table 2 implies that there were positive dynamics of changes in the level of coordination in all indicators during the study.

4. Discussions

The study attempted to examine how the upgraded system of training based on 12 exercises for the development of coordination abilities influenced the coordination of young footballers aged 9-10 years. It was found that the sampled students experienced an improvement in their ability to adjust and adapt motor actions and kinaesthetic differentiation of movements (ball sensation). The overall improvement is approximately 21% which is statically significant. The above agrees with the authors' opinion, this is due, firstly, to the special properties of the vestibular apparatus and nervous system of children of this age, and secondly, [14] emphasises that between the age of 7 and 9 years old, you cannot force a child to perform certain technical actions with a "weak" leg. Except if the child does it arbitrarily, due to his characteristics." The use of this indicator is justified by the fact that in the practice of sports training, especially at low stages of sports skills, scientists recommend focusing on the development of all seven coordination abilities, because in experimental studies of the authors, the possibility of compensating for the insufficient level of development of some coordination abilities at the expense of the development of others has been established. It was also found that there was shift in students' level of coordination from 'low' to 'average' and 'above'.

The study goes in line with the previous research. It aligns with [25] justifying that five tests to assess motor competence among young adults (Bruininks–Oseretsky Test of Motor Proficiency-2, McCarron Assessment of Neuromuscular Development, Movement Assessment Battery for Children-2, Tufts Assessment of Motor Performance and the Zurich Neuromotor Assessment) are reliable instruments providing the accurate result. It is consistent with [26] claiming that motor coordination problems are better addressed in the adolescence period.

5. Conclusions

The study proved that the upgraded system of training based on 12 exercises for the development of coordination abilities influenced the coordination in young footballers aged 9-10 years. The system of training also improved the students' abilities to adjust and adapt motor actions; kinesthetic differentiation of movements (ball sensation). The overall improvement was approximately 21% which was statically significant. The students were found to improve in the seven coordination abilities and it was also

found that there was shift in students' level of coordination from 'low' to 'average' and 'above'.

6. Recommendations

Both practitioners and researchers should analyse the relevance and appropriateness of the certain type of movement tasks that can lead to a greater change, and how these tasks may need to vary with age and/or relevance for adolescents and young adults. The researchers should study the possibility of compensating for the insufficient level of development of some coordination abilities at the expense of the development of others, especially at low stages of sports skills.

Limitations

The number of students and the involvement of only one football school can be seen as a limitation.

Acknowledgement

We are grateful to the coaches for their participation and advice in running the experiment. We are also grateful to the young footballers for being persistent and committed to succeed in training.

Conflicts of Interest

No scientific or financial conflicts of interest are reported by the authors.

Ethical Consideration

The study was conducted in accordance with ethical principles founded in the Declaration of Helsinki.

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