

Parameters of speed and strength as agility predictors in rugby

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Abstract

The paper highlights the impact of the accumulation (preparatory) period on the changes in the level of motor skills in rugby league players (n=20) of the first league in the Slovak Republic. Motor skills were measured using fifteen tests (Star Run, Zig-Zag Run, Agility T-Run, 22 m hopping & bounding test, diagonal run, bench press, barbell squat, deadlift, solid ball throw, standing long jump, 1-min push-ups, pull-ups, 30 m run, 1-min sit-ups, 1-min squats) during the months of September, November and December. Statistical significance of changes was monitored by t-test at 5% and 1% significance level. Stepwise regression made it possible to reveal the motor skills that determined performance in agility tests. The accumulation period enriched with developmental means of speed, speed-strength and strength abilities had a positive effect on the results of all motor tests ($p < 0.01$). The greatest correlation was observed between the lower limb explosive endurance (22 m hopping & bounding test, $Beta^*r = 0.663 - 0.834$), straight line acceleration (30 m run, $Beta^*r = 0.793 - 0.855$), and speed endurance (384 m diagonal run, $Beta^*r = 0.723$) on one side and the Agility Star run, Zig-Zag Agility Run and Agility T-Run on the other. The obtained results showed the focus of the preparatory period, which aims to develop the motor skills determining the game performance of players and the team. It was demonstrated that speed, speed-strength and strength skills are significant determinants of agility performance in the game of rugby. Compared to published standards, the general motor performance of the studied sample of rugby players is rated as average to poor.

Keywords: rugby league, stepwise regression, agility, skills, performance, men

Introduction

Rugby is one of the world's most widespread and popular sports games. Rugby is a team and full contact sport (Beneke, 2015). Modern rugby can make the spectator provide the right sporting experience. In recent years, there has been a drive to push sports performance to the highest level possible. Rugby is no exception, as the game has now become much faster due to rule changes, which have placed higher demands on the players. Every player has a certain level of strength and speed-strength skills, which should be improved further. Agility is a fundamental skill in rugby and its development is crucial for success on the field. Agility training in rugby is designed to improve balance, coordination and speed of the player, thus helping them outplay their opponents and improve their overall performance (Broďáni et al. 2021). The aim of agility training in rugby is to make players' movements more efficient, reduce the risk of injury and improve their athletic performance when under pressure (Rajput, Uppal & Chitkara 2016). Ultimately, rugby agility training can provide players with the physical and mental tools to deliver their best performance.

In this paper, we focus on testing rugby players during the accumulation period. We put the players through twelve tests focusing on strength and speed-strength skills that influence changes in agility. For example, rugby agility with running mode and technique alteration; complex rugby agility; agility change of all directions of movement, acceleration and deceleration; lower limb speed-strength abilities; speed endurance; upper body maximal strength; lower body maximal strength; whole-body maximal strength; abdominal and back muscle strength; lower limb explosive strength; upper limb endurance strength; upper body endurance strength; acceleration; abdominopelvic muscle endurance strength; lower limb endurance strength (Baker & Newton 2008, Comfort et al. 2011, Crewther et al. 2011).

Rugby is a distinct sport that has its own characteristic requirements, be they strength, speed or endurance. With this in mind, we sought to determine the impact of strength and speed-strength skills on changes in agility in rugby and to improve them through training exercises. Despite being a team sport, the individual side of the players needs to be taken into consideration. Namely, their individual performance differences, which can be improved through exercises and tests to bring the motor skills of all players to the same level of performance, from which they can continue the upward trend (Sapega & Drillings 1983).

Aim The aim of this paper was to show the effect of a 12-week accumulation period on changes in the motor skills of Rugby Union Club Piešťany players during such a period. A secondary aim was to highlight the motor skills determining agility performance in rugby during initial, interim and final measurements.

Material & Methods

The testing of the influence of strength and speed-strength skills on changes in agility in rugby involved 20 rugby players from Rugby Union Club Piešťany, who compete in the Slovak Respect League. The measurements took place in 2022 (1st measurement in September, 2nd measurement in November, 3rd measurement in December). The rugby players took adapted training sessions in order to achieve better results in the tests. Baseline somatic indices at the initial testing showed that the average body height of the rugby players was 183.35 cm, while the average body weight was 92.43 kg. The measurements allowed us to calculate the Body Mass Index (BMI), which reached a value of 27.49. The BMI value showed overweight for the tested category. The decimal age of the subjects was 23.5 years. The research required that rugby players actively participate in at least 75% of the training process. Players who had sustained a major injury or illness in the last year that could affect performance in each test were excluded from the pool. The coach and players were briefed on the aim and nature of the research.

The rugby players performed three agility tests: the Agility Star Run, the Zig-Zag Agility Run, and the Agility T-Run. Furthermore, they also performed 12 tests assessing their general fitness (Mackenzie, 2005): 22 m hopping & bounding test, diagonal run, bench press, barbell squat, deadlift, 2 kg solid ball throw, standing long jump, 1-min push-ups, pull-ups, 30 m run, 1-min sit-ups, 1-min squats. The test battery for most of the tests was devised by the eminent British Athletic Federation's coach Wilf Paish during his work with rugby players (Mackenzie, 1998).

Agility Star Run (rugby agility with alterations of running direction and techniques):

This test requires the athlete to run the circuit as fast as possible. An assistant sets up the cones according to the diagram. The balls are placed at marked positions A and E (A-B, B-C, C-D and D-A distances are 20 meters). The assistant gives the command "GO" and starts the stopwatch. The athlete starts at point A with the ball and runs to E, where he changes balls. He sprints around the cone to B and returns to E to change balls again. He then runs around the cones C and D similarly, every time changing the ball at E, and then back to A. The assistant stops the stopwatch and records the time when the athlete's torso crosses the finish line (Figure 1).

Zig-Zag Agility Test (comprehensive rugby agility):

This test requires the athlete to run through an agility "zigzag" circuit as quickly as possible. An assistant sets up the cones according to the diagram. The assistant gives the command "GO" and starts the stopwatch. The athlete runs from A to B, picks up the ball and runs to C, "zigzags" between the cones to D and then "zigzags" back to C. He then sprints to E, puts the ball down and sprints to F. The assistant stops the stopwatch and records the time when the athlete's torso crosses the finish line (Figure 2).

Agility T-Run (agility change of all directions of movement, acceleration and deceleration):

This run requires the athlete to touch a series of cones outlined in the shape of the letter "T" while backing off and running as fast as possible. The athlete warms up for 10 minutes. The assistant places three cones 5 meters apart in a straight line (A, B, C) and a fourth cone (D) is placed 10 meters from the middle cone (B) so that the four cones form a "T". The athlete stands at cone (D) at the base of the "T", facing the "T". The assistant gives the "GO" command, starts the stopwatch and the athlete begins the test. The athlete runs to the middle cone (B) and touches it, steps 5 meters sideways to the left cone (A) and touches it, steps 10 meters sideways to the far cone (C) and touches it, steps 5 meters sideways back to the middle cone (B) and touches it, and then runs 10 meters back to the base of the "T" and touches the cone (D). The assistant stops the stopwatch and records the time when the athlete touches the cone at the base of the "T" (Fig. 3).

Fig. 1 Agility Star Run

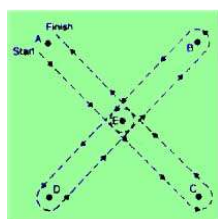


Fig. 2 Zig-Zag Agility Run

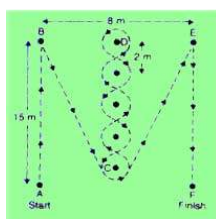
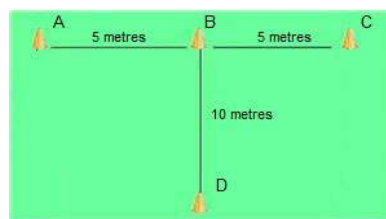


Fig. 3 Agility T-Run



22 m hopping & bounding test (lower limb speed and strength skills)

Diagonal run (speed endurance)

Bench press (upper limb, upper body maximal strength)

Barbell squat (lower limb, lower body maximal strength)

Squats (Dos Santos et al. 2023, Pedro et al. 2022, Zawies 2008, Stoppani 2006, Fehér 2006)

Deadlift (whole body maximal strength)

2 kg solid ball throw (strength of abdominal and back muscles) (Neuman 2003, Měkota & Blahuš 1983)

Standing long jump (lower limb explosive power) (Pasko et al. 2019, Moravec, Kampmiller & Sedláček 2002)

1-min Push-ups (upper limb endurance strength)

Pull-ups (upper limb endurance strength) (Boly 2019)

30 m run (acceleration)
1-min Sit-ups (endurance strength of the abdominopelvic muscles)
1-min Squats (lower limb endurance strength)

Experimental factor (Tab. 1)

Circuit workout A: with own weight 1. Parallel squats, 2. Push-ups, 3. Sit-ups, 4. Dumbbell Forward Lunges, 5. Planks, 6. Burpees, 7. Box Jumps.

According to Bompa et al. (2013), in order to calculate the training load, before starting, we should perform 1 RM (one-repetition maximum) testing for the basic exercises in this section.

Circuit workout B: with dumbbells and medicine ball 1. Barbell Squat, 2. Bench Press, 3. Deadlift, 4. Dumbbell Forward Lunges, 5. Burpees, 6. Planks, 7. Sit-ups, 8. Medicine Ball Wall Throws, 9. Box Jumps, 10. Triceps Push-ups, 11. Dumbbell Flyes.

Circuit workout C: with dumbbells and medicine ball

1. Barbell squats, 2. Bench Press, 3. Deadlift, 4. Dumbbell Forward Lunges, 5. Burpees, 6. Planks, 7. Sit-ups, 8. Medicine Ball Wall Throws, 9. Box Jumps, 10. Triceps Push-ups, 11. Military Press, 12. Overhead Backward Medicine Ball Throws, 13. Dumbbell Flyes.

Tab. 1 Examples of circuit workouts (Bompa & Buzzichelli 2015)

A: Bodyweight Circuit Workout	1. Pull-ups 2. Squats 3. Push-ups 4. Sit-ups 5. Forward Lunges 6. Plank 7. Burpees 8. Box Jumps
B: Circuit Workout with Dumbbells and Medicine Ball	1. Pull-ups 2. Dumbbell Squats 3. Bench Press 4. Dead Lift 5. Forward Dumbbell Lunges 6. Burpees 7. Plank 8. Sit-ups 9. Medicine Ball Wall Throw 10. Box Jumps 11. Triceps Push-ups 12. Dumbbell Chest Fly
C: Circuit Workout with Dumbbells and Medicine Ball	1. Pull-ups 2. Dumbbell Squats 3. Bench Press 4. Dead Lift 5. Forward Dumbbell Lunges 6. Burpees 7. Plank 8. Medicine Ball Wall Throw 9. Sit-ups 10. Overhead Backward Medicine Ball Throw 11. Box Jumps 12. Triceps Push-ups 13. Military Press 14. Squad Jumps 15. Dumbbell Chest Fly

The level of motor skills (agility, speed, strength) is characterized by descriptive statistics (n, M, SD, Max, Min). The selection of parametric methods was made on the basis of the assessment of the distribution normality.

Differences between initial, interim and final measurements were assessed by statistical analysis (t-test). Statistical significance of differences and relationships was verified at 5% and 1% significance levels.

The determination of factors limiting Agility skills was based on an assessment of the relationships between all variables. Stepwise regression analysis was used to reduce the variables and remove multicollinearity. These are tested in feedback to see if they statistically affect the quality of the regression model.

We estimated the dependence (Pearson's correlation coefficient "r") and partial proportions (β^*r) of each motor ability (tests) using correlation and regression analysis techniques. Among the regression parameters, we indicate the determinant of the multiple correlation (R^2) and the significance of the model (F). We also assess the statistical significance of the models at significance levels of $p < 0.05$ and $p < 0.01$.

In Table 1, we present descriptive statistics of the level of motor skills, mean values across all tests in the entry, interim and final measurements.

Table 2 Descriptive statistics of the level of motor skills

	Pretest		Continuous test		Posttest	
	M	SD	M	SD	M	SD
Star beh (s)	15,10	1,74	14,86	1,68	14,75	1,67
Zig Zag beh (s)	21,37	1,43	20,85	1,27	19,93	1,34
T agility beh (s)	12,36	0,97	12,14	1,07	11,96	1,10
30 m Sprint (s)	5,25	0,41	5,17	0,45	5,06	0,45
Diagonal Pitch Runs (s)	90,73	5,38	89,69	6,55	87,41	6,33
22 metre Hopping & Bounding Test (s)	57,29	6,31	55,96	6,21	54,08	6,32
Bench Press (kg)	69,75	24,09	72,00	23,53	76,75	23,69
Squat Bar (kg)	87,25	31,05	91,00	31,52	95,25	31,93
Deadlift (kg)	106,00	37,44	109,25	38,33	114,00	39,52
Throw with Medicine Ball 2 kg (m)	9,96	2,08	10,11	2,15	10,28	2,25
Broad Jump (cm)	208,75	26,12	211,85	26,77	216,25	27,09
Pull Up (n)	9,10	3,39	10,25	3,88	12,50	4,56
Push Up Test (n*min ⁻¹)	34,45	7,62	36,00	7,73	38,55	7,53
Sit-ups Test (n*min ⁻¹)	38,95	6,46	41,70	7,48	44,95	7,78
Squat Test (n*min ⁻¹)	45,60	5,95	49,25	6,12	52,30	6,23

Results

Changes in level of motor performance

Star Run

During the observation period, statistically significant changes occurred in rugby agility with changes in direction. The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 0.24$, $t = 5.87$, $p < 0.01$), between the interim and final measurements ($d = 0.11$, $t = 3.45$, $p < 0.02$), and between the entry and final measurements ($d = 0.35$, $t = 9.34$, $p < 0.01$). The level of agility improved by 0.35 s on average during the observed period ($M_{\text{input}} = 15.1$ SD = 1.74 $\rhd$ $M_{\text{output}} = 14.75$ SD = 1.67). Meanwhile, the level of the interim measurements reached values of $M = 14.86$ SD = 1.68.

Zig-Zag Agility Run

During the observation period, statistically significant changes occurred in comprehensive rugby agility. The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 0.53$, $t = 3.23$, $p < 0.004$), between the interim and final measurements ($d = 0.91$, $t = 4.80$, $p < 0.0001$), and between the entry and final measurements ($d = 1.44$, $t = 12.88$, $p < 0.000000001$). The level of agility improved by 1.44 s on average during the observed period ($M_{\text{input}} = 21.37$ SD = 1.43 $\rhd$ $M_{\text{output}} = 19.93$ SD = 1.34). Meanwhile, the level of the interim measurements reached values of $M = 20.85$ SD = 1.27.

Agility T-Run

During the observation period, statistically significant changes occurred in rugby agility with changes in direction, acceleration and deceleration. The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 0.22$, $t = 3.41$, $p < 0.003$), between the interim and final measurements ($d = 0.18$, $t = 2.38$, $p < 0.03$), and between the entry and final measurements ($d = 0.40$, $t = 5.00$, $p < 0.00008$). The level of agility improved by 0.40 s on average during the observed period ($M_{\text{input}} = 12.36$ SD = 0.97 $\rhd$ $M_{\text{output}} = 11.96$ SD = 1.10). Meanwhile, the level of the interim measurements reached values of $M = 12.14$ SD = 1.07.

During the observed period, statistically significant changes occurred in the lower limb speed and strength skills monitored through the 22 m hopping & bounding test. The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 1.33$, $t = 4.38$, $p < 0.01$), between the interim and final measurements ($d = 1.88$, $t = 4.45$, $p < 0.01$), and between the entry and final measurements ($d = 3.22$, $t = 7.55$, $p < 0.01$). The level of the lower limb speed and strength skills improved by 3.22 s on average during the observed period ($M_{\text{input}} = 57.29$ SD = 6.31 $\rhd$ $M_{\text{output}} = 54.08$ SD = 6.32). Meanwhile, the level of the interim measurements reached values of $M = 57.29$ SD = 6.38; in the speed endurance monitored through the diagonal run test. The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 1.03$, $t = 2.96$, $p < 0.01$), between the interim and final measurements ($d = 2.28$, $t = 12.28$, $p < 0.01$), and between the entry and final measurements ($d = 3.32$, $t = 12.10$, $p < 0.01$). The level of speed endurance improved by an average of 3.32 s during the observed period ($M_{\text{vstup}} = 90.73$, SD = 5.38 $\rhd$ $M_{\text{output}} = 87.41$ SD = 6.33). Meanwhile, the level of the interim measurements reached values of $M = 89.69$ SD = 6.55; in the maximal upper body strength monitored through the bench press test. The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 3.33$, $t = 3.33$, $p < 0.01$), between the interim and final measurements ($d = 0.11$, $t = 3.45$, p

<0.02), and between the entry and final measurements ($d = 7.00$, $t = 12.46$, $p < 0.01$). The level of the upper body maximal strength improved by an average of 7.00 kg during the observed period ($M_{\text{input}} = 69.75$, $SD = 24.09$ $\diamond$ $M_{\text{output}} = 76.75$ $SD = 23.69$). Meanwhile, the level of the interim measurements reached values of $M = 72.00$ $SD = 23.53$; in the lower body maximal strength monitored through the barbell squat test. The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 3.75$, $t = 7.55$, $p < 0.01$), between the interim and final measurements ($d = 4.25$, $t = 10.38$, $p < 0.01$), and between the entry and final measurements ($d = 8.00$, $t = 14.24$, $p < 0.01$). The level of lower body maximal strength improved by an average of 8.00 kg during the observed period ($M_{\text{input}} = 87.25$, $SD = 31.05$ $\diamond$ $M_{\text{output}} = 95.25$ $SD = 31.93$). Meanwhile, the level of the interim measurements reached values of $M = 91.00$, $SD = 31.52$; in the maximal whole-body strength monitored through the deadlift test. The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 3.25$, $t = 5.94$, $p < 0.01$), between the interim and final measurements ($d = 4.75$, $t = 8.32$, $p < 0.01$), and between the entry and final measurements ($d = 9.00$, $t = 10.51$, $p < 0.01$). The level of maximal whole-body strength improved by an average of 9.00 kg during the observed period ($M_{\text{input}} = 106.00$, $SD = 37.44$ $\diamond$ $M_{\text{output}} = 114.00$ $SD = 39.52$). Meanwhile, the level of the interim measurements reached values of $M = 109.25$, $SD = 38.33$; in the strength of the abdominal and back muscles monitored through the Medicine Ball Throw test (see Figure 9). The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 0.15$, $t = 2.53$, $p < 0.02$), between the interim and final measurements ($d = 0.17$, $t = 2.42$, $p < 0.03$), and between the entry and final measurements ($d = 0.32$, $t = 3.79$, $p < 0.01$). The level of abdominal and back muscle strength improved by an average of 0.32 m during the observed period ($M_{\text{input}} = 9.96$, $SD = 2.08$ $\diamond$ $M_{\text{output}} = 10.28$, $SD = 2.25$). Meanwhile, the level of the interim measurements reached values of $M = 10.11$ $SD = 2.15$; in the lower limb explosive strength monitored through the standing jump test. The positive effect of training content caused statistically significant changes between the entry and interim measurements ($d = 3.10$, $t = 7.69$, $p < 0.01$), between the interim and final measurements ($d = 4.40$, $t = 6.68$, $p < 0.01$), and between the entry and final measurements ($d = 7.50$, $t = 7.99$, $p < 0.01$). The lower limb explosive strength level improved by an average of 7.50 cm during the observed period ($M_{\text{input}} = 208.75$, $SD = 26.12$ $\diamond$ $M_{\text{output}} = 216.25$ $SD = 27.09$). Meanwhile, the level of the interim measurements reached values of $M = 211.85$ $SD = 26.77$.

Table 3 Differences in entry (Pretest), interim (Continuous test) and final (Posttest) measurements in tests of motor skills

	Differences					
	Pretest $\diamond$ Continuous test		Continuous test $\diamond$ Posttest		Pretest $\diamond$ Posttest	
	t	p	t	p	t	p
Star beh (s)	5,87	0,00	3,45	0,00	9,34	0,00
Zig Zag beh (s)	3,23	0,00	4,80	0,00	12,88	0,00
T agility beh (s)	3,41	0,00	2,38	0,03	5,00	0,00
30 m Sprint (s)	2,58	0,02	5,33	0,00	6,47	0,00
Diagonal Pitch Runs (s)	2,96	0,01	12,28	0,00	12,10	0,00
22 metre Hopping & Bounding Test (s)	4,38	0,00	4,45	0,00	7,55	0,00
Bench Press (kg)	3,33	0,00	10,78	0,00	12,46	0,00
Squat Bar (kg)	7,55	0,00	10,38	0,00	14,24	0,00
Deadlift (kg)	5,94	0,00	8,32	0,00	10,51	0,00
Throw with Medicine Ball 2 kg (m)	2,53	0,02	2,42	0,03	3,79	0,00
Broad Jump (cm)	7,69	0,00	6,68	0,00	7,99	0,00
Pull Up (n)	9,12	0,00	9,00	0,00	9,12	0,00
Push Up Test ($n \cdot \text{min}^{-1}$)	3,20	0,00	9,58	0,00	7,92	0,00
Sit-ups Test ($n \cdot \text{min}^{-1}$)	6,51	0,00	10,60	0,00	12,06	0,00
Squat Test ($n \cdot \text{min}^{-1}$)	7,65	0,00	7,06	0,00	10,26	0,00

Table 4 Stepwise regression of the reduced set of motor performance indicators to the Agility Star Run

		Standardized Coefficients					Correlation			Anova		
		B	SE	Beta	t	p	r	p	Beta*r	R ²	F	sig
Pretest	30 m Sprint	-5,421	1,994		-2,719	0,014						
		3,910	0,379	0,925	10,322	0,000	0,925	0,000	0,855	0,855	106,538	0,000
Continuous test	22 metre Hopping & Bounding Test	1,337	1,616		0,827	0,419						
		0,242	0,029	0,893	8,418	0,000	0,893	0,000	0,797	0,797	70,861	0,000
Posttest	30 m Sprint	-2,103	2,037		-1,033	0,315						
		3,331	0,401	0,891	8,305	0,000	0,891	0,000	0,793	0,793	68,974	0,000

The greatest contribution to the explanation of performance in the Star Run test (Table 4) in the entry measurement was made by the 30 m sprint (85 %, $t = 10.322$, $p < 0.01$, $F = 106.54$, $p < 0.01$), in the interim measurement, it was the 22 m hopping & bounding test (79 %, $t = 8.418$, $p < 0.01$, $F = 70.86$, $p < 0.01$) and in the final measurement, the 30 m sprint (79 %, $t = 8.305$, $p < 0.01$, $F = 68.97$, $p < 0.01$). All three prediction models achieved very high accuracy ($R^2 = 0.797 - 0.855$) and were statistically significant at $p < 0.01$.

Table 5 Stepwise regression of the reduced set of movement performance indicators to Zig-Zag Agility test

		Standardized Coefficients					Correlation				Anova	
		B	SE	Beta	t	p	r	p	Beta*r	R ²	F	sig
Pretest	22 metre Hopping & Bounding Test	10,783	1,789		6,027	0,000						
		0,185	0,031	0,814	5,954	0,000	0,814	0,000	0,663	0,663	35,448	0,000
Continuous test	Diagonal Pitch Runs	6,102	2,159		2,827	0,011						
		0,164	0,024	0,850	6,848	0,000	0,850	0,000	0,723	0,723	46,897	0,000
Posttest	22 metre Hopping & Bounding Test	9,922	1,313		7,555	0,000						
		0,185	0,024	0,875	7,673	0,000	0,875	0,000	0,766	0,766	58,881	0,000

In the case of Zig-Zag Agility test (Table 5), in the entry measurement it was the 22 m hopping & bounding test (66%, $t = 5.954$, $p < 0.01$, $F = 35.448$, $p < 0.01$) in the interim measurement the diagonal run (72%, $t = 6.848$, $p < 0.01$, $F = 46.897$, $p < 0.01$) and in the final measurement, the 22 m hopping & bounding test (76%, $t = 7.673$, $p < 0.01$, $F = 58.88$, $p < 0.01$). All three prediction models achieved very high accuracy ($R^2 = 0.797 - 0.855$) and were statistically significant at $p < 0.01$.

Table 6 Stepwise regression of the reduced set of movement performance indicators to the T - agility test

		Standardized Coefficients					Correlation				Anova	
		B	SE	Beta	t	p	r	p	Beta*r	R ²	F	sig
Pretest	22 metre Hopping & Bounding Test	4,414	0,906		4,871	0,000						
		0,139	0,016	0,901	8,820	0,000	0,925	0,000	0,834	0,812	77,798	0,000
Continuous test	22 metre Hopping & Bounding Test	3,729	1,101		3,386	0,003						
		0,150	0,020	0,875	7,687	0,000	0,875	0,000	0,766	0,766	59,083	0,000
Posttest	22 metre Hopping & Bounding Test	4,064	1,215		3,346	0,004						
		0,146	0,022	0,839	6,545	0,000	0,839	0,000	0,704	0,704	42,838	0,000

For the T-Run Agility Test (Table 6), in the entry measurement it was the 22 m hopping & bounding test (83%, $t = 8.82$, $p < 0.01$, $F = 77.798$, $p < 0.01$) in the interim measurement the 22 m hopping & bounding test (76%, $t = 7.687$, $p < 0.01$, $F = 59.01$, $p < 0.01$) and in the final measurement, the 22 m hopping & bounding test (70%, $t = 6.55$, $p < 0.01$, $F = 42.84$, $p < 0.01$). All three prediction models achieved very high accuracy ($R^2 = 0.797 - 0.855$) and were statistically significant at $p < 0.01$.

From the above analyses, it is evident that the greatest impact on performance in the Agility Star Run, Zig-Zag Agility Run, and agility T-Run tests was made by lower limb endurance explosiveness (22 m hopping & bounding test), which prevailed a total of six times, straight line acceleration, which scored twice (30 m run), and speed endurance (384 m diagonal run).

Discussion

We investigated the impact of the implemented training program on the development of motor skills using 9 tests designed by Mackenzie. The measurements were carried out in 2020, of which the 1st measurement took place in January, the 2nd measurement in July and the 3rd measurement in December. Whenever the conditions allowed it, the players trained two to three times a week and switched to individual training during the lockdown, which resulted in a deterioration in performance.

There were significant changes in the 30 m sprint in the first half of the year ($z = 2.84$, $p < 0.01$, $r = 0.52$), with an average improvement of 0.21 s. There were no performance gains in acceleration in the second half of the year ($z = 1.16$, $p = 0.25$, $r = 0.21$). The hypothesis of positive gains in motor skills, specifically in acceleration, was only confirmed in the first half of the year. De Lacey et al. (2014) investigated the 10 and 40 m sprint performance in 39 professional rugby players from the perspective of forwards and backs. They found that backs were significantly faster than forwards both in the 10 m sprint (+3.6%; $ES = 1.26$) and in the 40 m sprint (+5.3%; $ES = 1.61$). The rationale for this is that the forwards' body weight is significantly higher (+9%; $ES = 0.98$). Also, studies by Gabbet (2002) and Smit (2011) confirm that, compared to the backs, the forwards are taller, heavier and have a greater proportion of body fat with differences of up to 25%. Holmyard et al. (1994) argue, as do the authors mentioned above, that in the 30 m sprint, backs are also faster than forwards.

Agility Star Run acquired statistically significant changes in rugby agility with alterations in running direction and techniques ($X^2_r = 24.4$, $p = 0.0001$). We observed significant changes in the first half of the year ($z = 3.05$, $p < 0.01$, $r = 0.56$), where there was an average improvement of 1.1 s. In the second half of the year,

there were no performance gains in rugby agility with alterations in running direction and techniques ($z = 2.36$, $p = 0.02$, $r = 0.43$). As with the 30 m sprint, the hypothesis of positive gains was only confirmed in the first half of the year.

The 22 m hopping & bounding test did not change throughout the ATC ($X^2_r = 0.4$, $p = 0.81873$). Within each half-year period of observation, we did not note significant changes during the observation in the first half-year ($z = 0.20$, $p < 0.84$, $r = 0.04$), where there was an average deterioration of 0.09 s. In the second half-year, there were no performance gains in lower limb speed-strength skills.

Statistically significant changes during the observed period occurred in the endurance strength of the abdominopelvic muscles ($X^2_r = 21.7$, $p = 0.00002$) through the 1-min sit-up test. Within each half-year period of observation, we noted significant changes during the observation in the first half-year ($z = 3.29$, $p < 0.00$, $r = 0.60$), where there was an average improvement of 2.67 performed sit-ups. There were no performance gains in abdominopelvic muscle endurance strength in the second half of the year ($z = 3.20$, $p = 0.00$, $r = 0.58$). The hypothesis of positive performance gains in motor skills, specifically in the endurance strength of the abdominopelvic muscles, was only confirmed in the first half of the year. Hohenauer et al. (2017) compared forwards with backs in a 1-min sit-up test and found that forwards performed better ($P=0.03$, $d=1.38$) compared to backs.

In the 1-min squat test, there were statistically significant changes in lower limb endurance strength ($X^2_r = 14.8$, $p = 0.0061$). Within each half-year period during follow-up, we observed significant changes in the first half-year ($z = 2.50$, $p < 0.01$, $r = 0.46$), where there was an average improvement of 1.34 completed squats. There were no performance gains in lower limb endurance strength in the second half of the year ($z = 2.81$, $p = 0.00$, $r = 0.52$). The hypothesis of positive gains in motor skills, specifically in lower limb endurance strength, was only confirmed in the first half of the year.

During the observed period there were statistically significant changes in comprehensive rugby agility ($X^2_r = 30$, $p = 0.00001$) as monitored through the Zig-Zag Agility Run test. Within each half-year period during the observation, significant changes were noted in the first half-year ($z = 3.41$, $p < 0.01$, $r = 0.62$), where there was an average improvement of 1.996 s. There were no performance gains in comprehensive rugby agility in the second half-year ($z = 3.41$, $p = 0.00$, $r = 0.62$).

General running endurance was tested using Cooper's test and statistically significant changes occurred ($X^2_r = 16.1333$, $p = 0.0031$). Within each half-year period during observation, we noted significant changes in the first half-year ($z = 3.15$, $p < 0.01$, $r = 0.58$), where there was an average improvement of 130.67 m. In the second half-year, there were no performance gains in general running endurance ($z = 2.36$, $p = 0.02$, $r = 0.43$).

Also, statistically significant changes in upper limb strength endurance were observed in the 1-min push-up test ($X^2_r = 8.2333$, $p = 0.0163$). Within each half-year period during the observation, we noted significant changes in the first half-year ($z = 1.79$, $p < 0.71$, $r = 0.33$), where there was an average improvement of 1.8 completed push-ups. There were no performance gains in upper limb strength endurance in the second half-year ($z = 0.69$, $p = 0.49$, $r = 0.13$). In the 1-min push-up test, Hohenauer et al. (2017) did not find significant changes between forwards and backs ($P=0.97$, $d=0.01$). They performed the testing on seventeen rugby union players in Germany.

Statistically significant changes in endurance speed ($X^2_r = 19.0333$, $p = 0.00007$) occurred during the observation period as monitored by the diagonal run test. Within each half-year period during the observation, significant changes were noted in the first half-year ($z = 3.29$, $p < 0.01$, $r = 0.60$), where there was an average improvement of 2.35 s. In the second half-year, there were no performance gains in speed endurance ($z = 2.04$, $p = 0.04$, $r = 0.37$).

Walter (2006) also used test batteries to investigate the effect of the annual training cycle in the sports of handball and basketball. In both cases they also achieved improvements in motor performance using the conditioning training.

According to the results obtained from testing the rugby players, we can conclude that there is a need to improve the level of all motor skills, which need to be developed systematically. Since strength abilities determine sport performance and prevent injuries, we can also point to the study of Baker et al. (2008) who tested maximal strength using the 1 RM squat test. They observed 20 professional rugby players and compared two age groups of 29.5 ± 2.4 and 23.2 ± 0.8 . The older players achieved results of $x = 153.3 \text{ kg} \pm 12.1$ and the younger players $x = 182.5 \text{ kg} \pm 23.6$. Another test that can be used is the vertical jump, which was also used by Gabbett (2002), who tested 71 professional rugby players in different playing positions. The average performance for backs was 50.9 cm ($x_{\min} = 47.5 \text{ cm}$, $x_{\max} = 54.3 \text{ cm}$) and for forwards 48.7 cm ($x_{\min} = 42.1 \text{ cm}$, $x_{\max} = 55.3 \text{ cm}$).

Conclusion

In this paper, we demonstrated the changes in general motor performance of Rugby Union Club Piešťany rugby players during their annual training cycle 2020, when the outbreak of the Covid-19 pandemic significantly influenced the sporting events in the Slovak Republic.

Despite the pandemic limitations, the level of general physical performance of the rugby players showed an upward trend during the annual cycle.

Statistically significant improvements throughout the ATC ($p < 0.01$) were noted in running acceleration (30 m sprint), abdominopelvic muscle endurance strength (1-min sit-ups), lower limb endurance strength (1-min squats), comprehensive rugby agility (Zig-Zag Run), upper limb strength endurance (1-min push-ups), and speed endurance (diagonal run).

We observed deterioration in the second half-year ($p < 0.05$) in the Star Run (rugby agility with alterations in running direction and techniques) and the Cooper test (general running endurance). Performance in the 22 m hopping & bounding test remained the same throughout the ATC.

Compared to published standards, the general motor performance of the studied sample of rugby players is rated as average to poor.

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