EFFICIENCY OF JUMPING PREPARATION IN YOUNGER PUPILS IN ATHLETICS

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Ivan Čillík, Miriam Karperová

Department of Physical Education and Sport, Faculty of Arts Matej Bel University Banská Bystrica, Slovakia

ABSTRACT

The aim was to find out, compare and evaluate the efficiency of take-off preparation for selected indicators of motor performance in athletes in the category of younger pupils. The monitored group consisted of 5 girls (average age 12.4 ± 0.22 year) and 4 boys (average age 12.9 ± 0.12 year) regularly participating in the training process three times a week. During 8 weeks in the racing period, take-off preparation was applied in the training process, consisting of two different batteries of take-off drills. The take-off preparation took place two to three times a week, taking into account the participation of athletes in the race. We performed the following tests to determine the efficiency of the take-off preparation to change the level of motor performance in selected indicators: 50m run, 20m cursory run, standing long jump, vertical jump with countermovement without arm swing and repeated vertical take-off drills without arm swing in 10s. We found that in the output measurement, the athletes of monitored group achieved an improvement in motor performance in tests for explosive power of lower limbs and the maximum running speed tests.

Keywords: maximum running speed; take-off preparation; sport preparation; explosive power of lower limbs

Introduction

The basic task in training children according to Katzenbogner (2004) is to create fitness basics, to teach children simple but high quality motor skills and abilities, to create a space for new social links, meaningfully use their free time and thus shape their personality. Čillík (2004), Kučera et al. (2011) draw attention to the need for adequate training with regard to physical development and the level of adaptation skills. This is especially true in the age of 10–15 years, due to the turbulent changes in physical development, when children in athletics are in the stage of basic sports training. Change from childhood to adulthood – is typical for the age between 10 and 15 years. It is a period when the body undergoes significant changes, both biological and psychological, develops in the field of social relations and motor skills. This development is uneven, affects mainly motor skills and mental development, so it is necessary to take into account the specificity in the training of athletic disciplines (Čillík a kol., 2013). According to Hawkins (2010), by the end of the 10–15 years age period, children have increased aerobic capacity and their anaerobic capacity, along with the acceptance of the training stress that is placed on them, is generally becoming greater. Although their tolerance of negative effects during lactic acid accumulation is already at a better level, physical immaturity of bones, tendons, muscles and changes in body structure affect training methods in puberty. The training should provide general physical development achieved through general and versatile exercises that are relevant to the discipline. Sport-specific exercises in this phase of training create 15–25% of the training volume. Exercise volume increases more than intensity, increasing intensity must be carefully controlled.

Vanderka (2014) refutes myths about strengthening children and youth that talk about developing strength and negative influence on body growth and injuries. The development of strength abilities also affects the nervous, circulatory and respiratory systems, and this affects the development of the passive musculoskeletal system. Based on current knowledge in a complex understanding of the problem, strengthening seems to be very beneficial also in childhood. However, the assumption is a professional guidance in the application of fitness exercises. Exact scientific observations, together with the practical experience of youth trainers, show that even in children, muscle strength is manifested by improved performance across a range of speed-strength motor tests (e.g. vertical jump, acceleration and maximum speed).

Each manifestation of explosive power consists of two components: the velocity, which has sensitive periods in the ontogenesis of an individual under 12–13 years; we try to perform each exercise as quickly as possible, the number of repetitions in the series is low, or there is only one repetition - this achieves stimulation of this component, the problem at this age is to achieve an adequate concentration for one-time maximum acceleration; strength, which we improve through the development of muscles - this component is recommended to apply thoughtfully, especially due to the ontogenesis of the body. Sedláček et al. (2003) states that reflective explosiveness can be effectively developed from 9–10 years up to 18–20 years. In the period of 13–14 years, the most suitable conditions for the development of the speed component, e.g. the ability to reflect in the shortest possible time. For the age category 12–13 years, the most suitable take-off drills of horizontal and vertical character are performed without an additional load.

In relation to the setting up a training program, it is important to prevent an increase in the intensity of the training load by appropriate volume increasing (Corbin, Pangrazi, 2003). Shimon (2011) adds that the development of speed skills and agility has a firm and irreplaceable role in the early stages of a long-term sports training. Kučera et al. (2011) consider speed abilities in children as a basis and primarize them along with agility over all other abilities, but they add that we must not emphasize special development of speed through special exercises in any case, but develop speed through general training. In our study, we focused on athletes at a younger school age and investigated the impact of a motion program with a focus on the take-off drills on selected speed and speed-strength abilities.

Methods

Athletes regularly attending athletic training participated in the research. Monitored group consisted of ten athletes aged 11–13 (table 1). The group of girls consisted of five athletes (average age 12.4 ± 0.22 year) and the group of boys consisted of 4 athletes (average age 12.9 ± 0.12 year). There were six athletes who were also the students of secondary sports school.

Table 1 *Individual indicators of athletes of monitored groups*

Athlete	Age	Sport age	Decimal age (input)	Performance		Performance	
				60 m (input)	60 m (output)	60 m hurdles (input)	60 m hurdles (output)
SE	12	1.5	12.49	9.92	10.40	X	X
FA	12	3.5	12.66	10.18	9.61	12.15	11.32
ŠI	11	3.5	11.91	9.52	9.95	X	X
PA	13	4.0	13.23	9.22	9.43	X	11.47
MO	11	1.5	11.60	9.71	9.72	X	X
PE	11	3.0	12.98	8.96	8.85	X	
HR	13	3.0	13.26	8.00	7.77	X	
KA	12	3.0	12.62	9.58	9.59	12.56	
VA	12	4.0	12.98	9.36	9.13	X	

The research period, during which we applied the assembled battery of take-off drills, lasted for 8 weeks. The athletes received 2 to 3 training sessions a week, taking into account the eventual start at the race in that week. In the monitored season, athletes had to complete 23 training units lasting for 60–75 minutes. These training units always contained one of the batteries of take-off drills, except for the main part of the training. The length and volume of take-off drills were compiled in accordance with Sedláček et al. (2003), who recommends a minimum of 3 to 4 weeks, with the number of training units 2 to 3 per week in order to achieve adaptation changes to increase explosive power.

Sports training during the race season of the monitored group was focused primarily on the development of speed and speed-strength movement abilities. In the category of younger pupils, the trainings included more special preparation for individual disciplines. Except for the take-off drills included in each training unit, the athletes underwent training in high jump, long jump, hurdles and cricket throw. Input and output measurements were performed at the athletic stadium with an artificial surface and the weather conditions were consistent. Input temperature 20°, wind support in the range from +0.7 to +1.1 $m.s^{-1}$, output temperature 21°, wind support range from +0.6 to +1.0 $m.s^{-1}$.

At the beginning of the research, before the initial measurements, we asked the parents of the athletes forming the experimental group for their cooperation and consent. Before implementing the research, we performed measurements of somatic parameters – body height, body weight, the length of legs and BMI index. The length of lower limbs – athletes stood barefoot in a standing position on the mat and we measured the direction from the mat to the highest point on the large plume of femur (trochanterion) using a tailor's meter (Fančovičová, 2011).

To find out the level of motor performance of speed and speed-strength abilities, we have chosen these tests implemented in the following order:

1. repeated vertical jumps in 10 s, hands on hips – ankle drills (test of eccentric-concentric contraction), only ankle joints involved in the take-off (SSC);
2. vertical jump with countermovement without using arm swing, hands on hips (test of eccentric-concentric contraction), ankle, knee and hip joints involved in the take-off;
3. standing long jump (test for explosive power of lower limbs);
4. 50m run from half standing start (test of running speed);
5. 20m cursory run (test of maximum running speed).

The selection of tests was based on the intention to determine the effectiveness of the program on the level of speed abilities and the level of reflective explosiveness. In speed abilities, we found maximum running speed (20 m cursory run) as a decisive assumption of performance for sprinting and jumping disciplines. Running for 50m is a comprehensive test of running speed. Long jump is a comprehensive test of the reflective explosiveness of lower limbs. The test of eccentric-concentric contraction repeated jumps shows the ability to quickly stretch and shorten in a minimal time interval (plyometry – SSC), using only ankle joints. The test vertical jump with countermovement expresses the ability of muscular eccentric-concentric contraction over a longer period of time and involving a greater number of motor units.

The rest interval between each test was sufficiently long. Nevertheless, the testing lasted for 100 minutes including warm-up and stretching, which can be quite tedious if we want athletes to perform their best. However, the experimental group consisted of athletes who were fit enough to handle the test load. We used photocells to measure speed abilities. We used a timekeeper – Witty (Microgate), designed for sport and training, to record the results of speed abilities. We also used OptoJump Next to measure speed- power abilities. Next is a device designed to measure and objectify the main properties of jump, as the flight and the contact time with a pad (Biasi, 2013). Experimental programme included two sets of take-off drills (tables 2, 3).

Table 2 *Take off drills – set I*

	Exercise description	Number of repetitions
1.	Ankle drills	10
2.	High knee skip	10
3.	Power skipping (right, left)	10
4.	Power skipping (double jumps) (right, right, left, left)	12
5.	Power skipping (right, left) running method	10
6.	Take-offs over 20 cm hurdles (5 hurdles), take-off from right leg, landing on left leg (1 step between hurdles)	5 + 5
	Number of repetitions together:	**62**

Table 3 *Take-off drills – set II*

	Exercise description	Number of repetitions
1.	Cone hops (6 small cones) – front position (front-front-back-front-front-back...)	16
2.	Cone hops (6 small cones) – lateral position (front-front-back-front-front-back ....)	32
3.	Power skipping (Right, left)	6
4.	Box jumps (40 cm) – without jumping off the box, just stepping off the box	6
5.	Frog jumps	5
	Number of repetitions together:	**65**

Planned volume load in the monitored programme of take-off drills was 127 in the first week. During the experimental period it was 3547 repetitions in 23 training units. All monitored athletes completed at least 80 = planned training load (table 4).

Table 4 *Completed training load of athletes during the monitored period*

Training indicators	SE	FA	ŠI	PA	MO	PE	HR	KA	VA
1. Days of loading (number)	21	19	19	19	22	23	20	21	21
2. Load units (number)	21	19	19	19	22	23	20	21	21
3. Duration of the load (hour)	24.0	22.25	21.75	22.0	25.25	26.5	23.0	24.25	24.25
4. Number of competitions (number)	1	3	2	2	1	3	2	1	3
5. Gymnastics (hour)	0	0	0	0	0	0	0	0	0
6. Games (hour)	1.83	1.83	1.83	1.33	1.83	1.83	1.83	1.83	1.83
7. Swimming (hour)	0	0	0	0	0	0	0	0	0
8. Hiking, skiing, skating (hour)	0	0	0	0	0	0	0	0	0
9. Coordination exercises (hour)	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
10. Speed exercises (hour)	2.95	2.61	2.45	2.45	3.45	3.45	1.95	1.95	3.45
11. Endurance exercises (hour)	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
12. Take-off drills (number)	**3175**	**2850**	**2856**	**2794**	**3361**	**3547**	**2989**	**3237**	**3175**
13.Strengthening exercises (hour)	0.83	35	0.83	0.83	1.08	1.08	0.33	0.83	0.58
14. Training of running techniques (hour)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95
15. Training of hurdle run technique (hour)	2.06	2.06	1.28	2.06	2.06	2.06	2.06	1.53	2.06
16. Training of jumps technique (hour)	2.28	2.28	2.28	2.28	2.28	3.03	2.28	3.03	2.28
17. Training of shots and throws (hour)	0.56	0.36	0.56	0.56	0.56	0.56	0.56	0.56	0.56
18. Warm up, stretching, cool down with running at an easy pace (hour)	7.0	6.33	6.33	6.33	7.33	7.66	6.66	7.0	7.0

The non-parametric Wilcoxon test for 2 dependent selections was used to determine the significance of the differences between the input and output measurements in the monitored parameters. In the terms of practical significance, the coefficient effect size “r” (Corder - Foreman, 2009) was used and interpreted as follows: r = 0.10 - low effect, r = 0.30 - medium effect, r = 0.50 – large effect (Cohen, 1988). The probability of error type I. was set to α = 0.05 in all analyzes. The statistical analysis was performed using the computer programs IBM®.

Results

Despite a short intervention period (8 weeks), we recorded changes in the monitored group of children in monitored somatic parameters. Body height increased on average by 2cm, body weight increased over 1kg for girls and 0.3kg for boys, and the length of lower limbs increased on average by more than 1cm (tables 5, 6). We recorded a slight decrease only in BMI.

Table 5 *Values of somatic parameters at the beginning and at the end of monitored period – girls*

INPUT					OUTPUT		
	Body height (cm)	**Body weight (kg)**	**Length of lower limbs (cm)**	**BMI (i)**	**Body height (cm)**	**Body weight (kg)**	**Length of lower limbs (cm)**
1	156.0	37.5	86.0	15.41	159.0	38.0	88.0
2	160.0	40.6	88.0	15.86	162.0	41.5	89.5
3	160.5	47.9	82.0	18.63	163.0	48.5	84.0
4	166.0	53.2	86.0	19.31	167.0	53.5	87.0
5	158.0	44.7	88.0	18.03	160.0	47.9	89.5
Mean	160.1	44.78	86.0	17.45	162.2	45.88	87.6

Table 6 *Values of somatic parameters at the beginning and at the end of monitored period – boys*

INPUT					OUTPUT		
	Body height (cm)	**Body weight (kg)**	**Length of lower limbs (cm)**	**BMI (i)**	**Body height (cm)**	**Body weight (kg)**	**Length of lower limbs (cm)**
1	157.0	47.2	85.0	19.07	160.0	48. 0	87.0
2	160.5	47.4	85.0	18.25	162.0	47.0	86.0
3	149.5	36.0	80.0	16.11	151.0	36.5	81.0
4	160.0	48.5	84.0	18.75	161.0	49.0	85.0
Mean	156.75	44.8	83.5	18.0 5	158.5	45.1	84.0

Table 7 *Values of speed and speed-strength indicators in the group of girls*

	INPUT	**OUTPUT**	**Wilcoxon test**	**Effect size**
	X	X		
VV [cm]	26.52 ± 1.92	27.38 ± 2.47	Z = -0.674, p > 0.05	r = 0.38 medium
OP [cm]	25.25 ± 1.18	27.16 ± 0.48	Z = -1.483, p > 0.05	r = 0.83 large
SLJ [cm]	187.2 ± 17.68	191.8 ± 16.77	Z = -1.461, p > 0.05	r = 0.82 large
50 m [s]	7.90 ± 0.21	7.83 ± 0.21	Z = -2.023, p < 0.05	r = 1.14 large
20 m [s]	2.97 ± 0.07	2.93 ± 0.08	Z = -2.032, p < 0.05	r = 1.14 large

Notes: VV – vertical jump with countermovement, OP – repeated jumps, SLJ – standing long jump; 50 m run; 20 m cursory run.

In the vertical jump test with countermovement without using arm swing, 4 athletes showed an improvement (by 0.1cm to 2.8cm) and one athlete reached worse results (2.5cm). The difference between input and output testing is not statistically significant (table 7). Practical significance is at the level of medium effect and the average percentage improvement is 3.4%. 4 athletes improved and 1 worsened also in the repeated jumps test. With the small number of members of the group (n = 5), the difference between input and output testing is not statistically significant but practical significance is at the level of large effect (table 7). Percentage improvement on average by 4.2% is the most significant of all tests in the group of girls. Three competitors improved in the standing long jump, one athlete worsened and one achieved the same performance in the input and output measurements. The difference between input and output testing is not statistically significant, but practical significance is at the level of large effect with an improvement on average by 4.6cm (table 7). The average percentage improvement was 2.5%.

In the tests of speed abilities 50 m run and 20 m cursory run, we recorded an improvement of all athletes in both tests. The differences between the input and output tests are statistically significant and practical significance is at the level of large effect (table 7). In the 50m run, the improvements are on average by 0.07s (0.9%) and at 20 m cursory run on average by 0.04s (1.0%).

Table 8 *Values of speed and speed-strength indicators in the group of boys*

	INPUT	OUTPUT	Wilcoxon test	Effect size
	X	X		
VV [cm]	30.9 ± 9.13	32.02 ± 9.05	Z = -1.841, p > 0.05	r = 1.09 large
OP [cm]	27.68 ± 5.05	28.08 ± 3.83	Z = -1.826, p > 0.05	r = 1.09 large
SLJ [cm]	194.75 ± 15.19	202 ± 14.07	Z = -1.826, p > 0.05	r = 1.09 large
50 m [s]	7.64 ± 0.77	7.54 ± 0.75	Z = -1.826, p > 0.05	r = 1.09 large
20 m [s]	2.87 ± 0.26	2.82 ± 0.31	Z = -1.841, p > 0.05	r = 1.09 large

Notes: VV – vertical jump with countermovement, OP – repeated jumps, SLJ – standing long jump; 50 m run; 20 m cursory run.

We recorded an improvement in the output measurement of each athlete in all the tests. The improvements in the individual tests are not statistically significant but the practical significance is at the level of large effect (table 8). In the vertical jump test with countermovement without using arm swing, we noted an improvement by 0.4–2.3cm, which is an improvement on average by 3.9%. In repeated jumps, the improvement was 0.3–3.2cm, on average by 4.6%. In the standing long jump, everyone improved by 5–10cm, on average by 3.9%.

In the tests of speed abilities, athletes improved by 0.1s (1.2%) at 50m running and by 0.05s (1.1%) at 20m cursory run.

Discussion

When developing the program for the development of reflective explosiveness, we used our own knowledge and experience with training in mentioned category. Despite the fact that there is a lot of knowledge about the training of children in the category of younger pupils, trainers do not follow the basic principles of training due to the effort to improve performance quickly.

The increase in somatic indicators (length parameters and body weight) by 1.2–2.5% during the 8-week monitored period confirms that monitored children are in the period of growth sprint. Monitored athletes are a select group that achieved more favourable somatic indicators than the Slovak population of children - higher body height and weight and lower BMI.

The monitored groups consisted of athletes aged 11–13, who have been continuously engaged in sports training in athletics for 3–4 years (only in two cases 1.5 years). The implemented block was adequate due to the level of physical development and level of training and comprehensively focused on the development of the take-off abilities. In both groups, the reflective explosiveness (standing long jump), the eccentric-concentric contraction of the plyometric character (repeated vertical jumps) and the eccentric-concentric contraction of the lower limbs were improved over a longer period of time and with a greater number of motor units (vertical jump with countermovement).

The female athletes achieved on average in the output measurement performance 191.8cm in the standing long jump. Brown (2001) states the standard for the selection of talent at the age of 11–13 years performance 187.33cm. The performance of monitored female athletes is better than it is stated in the curriculum for sports classes with a focus on athletics (Čillík, 2003) for 12–13 years old, where the performance standard in the standing long jump is 170.5cm. The female athletes of the monitored group show higher performance in both cases. The male athletes achieved on average in the output measurement performance 202cm in the standing long jump. Brown (2001) states an average performance 194.33cm for 11–13 years old boys and the curriculum for sports classes (Čillík, 2003) states the performance standard 178.5cm for 12–13 years old boys. The male athletes of the monitored group also achieved higher performance in both cases.

Even in the test 50 m run the monitored group of girls and boys achieved better performances than the performance standards states for sports classes. In 50 m run, female athletes achieved an average performance in output measurement 7.83 s. The performance standard is 8.8s for 12–13 years old girls. Male athletes achieved an average performance in output measurement 7.54s in the test 50m run. The performance standard in the curriculum is 8.55s for 12–13 years old boys.

Conclusion

We confirmed that in just 8 weeks, at a frequency of two to three training units per week, there may be significant changes in performance in the tests: vertical jump without countermovement, repeated jumps for 10s, standing long jump, 50m run and 20m cursory run. The results indicate that the program of take-off drills, which the athletes underwent at least 79%, had a positive effect on performance increase in the explosive power of lower limbs and in running speed.

Except for the program of take-off drills that athletes underwent, it is necessary to take into account the overall training load, which positively influenced the development of speed and speed-strength abilities. This means that other training means significantly contributed to the increase in performance in selected tests, which the athletes underwent.

Due to the small number of members of the groups and different ongoing physical development, we cannot generalize our results to the whole population and wide age range.

Reflective explosiveness plays an important role in athletics as well as in many other sports. Its development is linked to the consequent increase in the level of performance at maximum running speed.The age category of younger pupils is the best time to start developing it. The development of the speed component of the take-off should predominate its strength component.

The inclusion of take-off drills in sports training for younger pupils has been confirmed as the right way to develop the reflective explosiveness and speed abilities. As a part of the training process, we recommend applying different combinations of the take-off drills, whether in the form of repetitions of the take-off in a series or in the form of competition games or obstacle courses, all with consideration of age and preparedness level of the athletes.

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