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THE EFFECT OF DIFFERENT STRENGTH TRAINING PROGRAMS ON YOUNG ATHLETES' SPRINT PERFORMANCE

Key words: sprinting, strength, acceleration, velocity, performance.

ABSTRACT

The aim of this study was to investigate the effect of strength training on sprinting performance. 27 young male athletes were divided into three groups: neuro-muscular (NGroup), hypertrophy (HGroup) and control (CGroup). The athletes in NGroup and HGroup were training 3 times per week for 8 weeks. The fastest times of 30 m and 60 m testing trials were recorded prior to, in the middle of and at the end of the training program. ANOVA revealed a significant improvement in fastest times in both 30 m (8%) and 60 m (5.9%) runs in the athletes from the NGroup. Similarly, the improvement in speed of HGroup athletes was 6.2% in 30 m and 5.2% in 60 m, respectively, while a slight improvement in fastest times in 30 m (2.1%) and 60 m (2.4%) was shown in the CGroup athletes. Conclusively, a greater improvement in speed in both 30 m and 60 m was observed in the athletes from the NGroup.

INTRODUCTION

Strength training is an important factor in annual training planning for maximal velocity in modern sprint races. In the last decade an increase in the use of strength training in young athletes' training has been noted, especially at the perfection stage of training in athletes aged 17 to 20 years. The main goal of this training stage is to realize athletes' technical potential in strength training in order to avoid injuries [1]. Another study [2] confirmed the beneficial role of strength training for young athletes in their future ultimate performance during adulthood. In the period when motor abilities mature and advanced mastery is achieved, strength training can influence the structural make-up of the young athlete's body, especially in terms of the quantity and quality of muscle tissues leading to muscular hypertrophy [3, 4]. A number of studies have demonstrated the significance of both maximal strength and speed strength training in sprinters' performance [5, 6, 7, 8, 9]. Following the same design, in a study of two groups of participants (strength group and control group) a maximal strength training and jumping exercises program was applied 3 times per week, and the 40 m sprint fastest time was recorded after 9 weeks. The results showed that both groups improved in their speed performance with the participants of the strength training program displaying a greater level of improvement than the control group [7]. In another study, which assessed the effects of a nine-week program, the researchers confirmed a significant improvement in subjects' sprinting performance as well as in arm strength after maximal effort strength training [10]. Furthermore, a study examining the influence of a nine-week strength training program on athletes'

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best time in a 100 m run revealed that a strength training program combined with maximal strength training and speed strength exercises, had a beneficial effect both in the acceleration phase at the first 35 m as well as in the max speed phase between 35 and 100 m in a 100 m event. The results of a study of the interaction between strength and speed in 20 young sprinters showed that the athletes' strength performance was related, however, in a different way, to acceleration and the maximal speed phase in a 100 m race [11]. Similarly, studies measuring the effect of different strength training programs in basketball and football playersconfirmed that the strength training improves speed in absolute terms [12, 13].

In contrast, in the early 1980s, one study reported that running performance after a training program with resistance exercises revealed no improvement in a 40 yard sprint [14], while later a number of studies supported that strength training had a negative effect on speed, and that sprinters must train only maximum velocity sprints as well as speed strength exercises based on body mass resistance [15, 16]. Similarly, researchers who examined the relationship between strength training and sprinting performance reported that the improvement in athletes' maximal strength does not have any positive impact on their sprinting ability as measured by athletes' fastest time [17, 18]. Yet other researchers examining the influence of high-resistance and high-velocity training on sprinting performance recommended that a combination of strength and speed training could offer a significant improvement in sprinters' performance [19].

The objective of the present study was to investigate the effect of two different strength training programs, using neuro-muscular coordination and muscular hypertrophy methods in young athletes' sprinting performance in 30 m and 60 m runs.

METHODS

Subjects

A total of 27 male athletes volunteered to participate in the study and gave their written informed consent. Prior to the beginning of the testing protocol, oral instructions were provided about the nature of the research as well as what the athletes should avoid before and after the measurements. The athletes had similar training experience (4-5 years) and trained for speed-power events in athletics. The subjects were divided into three groups of nine: the Neuro-muscular Group (17 ± 0.8 years, body height 177 ± 0.1 cm, body mass 64 ± 10.1 kg); the Hypertrophy Group (16.8 ± 0.9 years, body height 177 ± 0.1 cm, body mass 66.5 ± 7 kg); and the Control Group (16.7 years, body height 173 ± 0.1 cm, body mass 68.2 ± 14.3 kg).

Research Design

The athletes from the Neuro-muscular Group (NGroup) participated in a maximal strength training program using the neuro-muscular coordination method (inter- and intramuscular coordination and synchronization) three times a week [20] as well as following a sprint running program two times per week, for eight weeks. Similarly, the Hypertrophy Group (HGroup) participated in a maximal strength training program using the hypertrophy method (stimulating muscles to gain muscle mass) three times per week [21, 22], and the same as the Neuro-muscular Group sprint running program two times per week, for eight weeks. In addition, the Control Group (CGroup) did not perform any strength training program but only the sprint running program two times a week for the period of eight weeks. The sprint testing trials were set before the beginning of the program (pre), in the middle (4^{th} week) as well as at the completion (8^{th} week) of the training period (post). The speed measurements were applied in three consecutive time trials of 30 m and 60 m. The research design for the eight-week training period is presented in Table 1.

Protocol

The subjects were weighted on an electronic scale (SECA 770) to the nearest 0.5 kg, with shoes and sweaters. Standing height was measured to the nearest 0.5 cm with each subject's shoes off, feet together, and head in the Frankfort horizontal plane using a stadiometer (SECA 240). Furthermore, in this preliminary session the subjects were measured in the 1-RM in Semi-Squat and Leg Extension exercises.

Prior to the sprint trials, the athletes performed a warm-up which included 10 minutes of jogging and dynamic exercises for the lower limbs. All the tests were carried out on an indoor track in identical conditions, at a temperature between 20°C

Table 1. The 8-week-training program (Strength, Multiple Jumps and Speed exercises) undertaken by the Neuro-muscular, Hypertrophy and Control Groups

	NEURO-MUSCULAR GROUP	HYPERTROPHY GROUP	CONTROL GROUP
MONDAY	*Strength:* 1) Semi-Squat 5 x 3 reps. x 90% 2) Leg Extensions 5 x 3 reps. x 90%	*Strength:* 1) Semi-Squat 4 x 8 reps. x 80% 2) Leg Extensions 4 x 8 reps. x 80%	
TUESDAY	*Speed*: 3 x 30 m & 3 x 60 m *Jumps:* 2 x 8 reps. x Drop Jumps* 2 x 8 reps. x 6 hurdles** (*jump-landing with both legs*)	*Speed*: 3 x 30 m & 3 x 60 m *Jumps*: 2 x 8 reps. x Drop Jumps* 2 x 8 reps. x 6 hurdles** (*jump-landing with both legs*)	*Speed:* 3 x 30 m & 3 x 60 m *Jumps:* 2 x 8 reps. x Drop Jumps* 2 x 8 reps. x 6 hurdles** (*jump-landing with both legs*)
WEDNESDAY	*Strength*: 1) Semi-Squat 5 x 3 reps. x 90% 2) Leg Extensions 5 x 3 reps. x 90%	*Strength:* 1) Semi-Squat 4 x 8 reps. x 80% 2) Leg Extensions 4 x 8 reps. x 80%	
THURSDAY	*Speed*: 3 x 30 m & 3 x 60 m *Jumps*: 2 x 8 reps. x Drop Jumps* 2 x 8 reps. x 6 hurdles** (*jump-landing with both legs*)	*Speed:* 3 x 30 m & 3 x 60 m *Jumps:* 2 x 8 reps. x Drop Jumps* 2 x 8 reps. x 6 hurdles** (*jump-landing with both legs*)	*Speed:* 3 x 30 m & 3 x 60 m *Jumps:* 2 x 8 reps. x Drop Jumps* 2 x 8 reps. x 6 hurdles** (*jump-landing with both legs*)
FRIDAY	*Strength:* 1) Semi-Squat 5 x 3 reps. x 90% 2) Leg Extensions 5 x 3 reps. x 90%	*Strength:* 1) Semi-Squat 4 x 8 reps. x 80% 2) Leg Extensions 4 x 8 reps. x 80%	

** Drop Height: 45 cm*
*** Hurdles Height: 56 cm*

to 25°C. In both 30 m and 60 m sprint trials each athlete was standing 50 cm back of the starting line in standing start waiting for the examiner's command "GO". The athletes were instructed to perform the sprint runs as fast as they could. Each athlete ran a total of maximal 3 sprints over 30 m and 60 m and the fastest time of the three runs in each distance was recorded. The running speed was recorded electronically (Performance Pack-Model 63520, Lafayette Inc.) with the use of three pairs of transmitter-photocells on the starting line as well as on the 30 m and in 60 m finish lines (Infrared Photocell Control Model 63501 R). The testing speed trials were recorded in accordance with the Technical Rules for International Competitors [23].

Statistical analysis

The statistical design for the measured variables in the present study was based on the Analysis of Variance (ANOVA). The interaction among the variables in each training group (3 x 3) was assessed in the analysis of the dependent factor "measurement" (pre-mid-post training) and with the independent factor "Group" (NG-HG-CG). Tukey's HSD test (post hoc) was applied to identify inter-group statistically significant differences in the measured variables. The level of statistical significance was set at 0.05 and all results were reported as mean ± standard deviation. SPSS statistical software version 16.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for data management and statistical calculations.

RESULTS

30 m sprint

The statistical procedures revealed a significant interaction between the three groups at all measurements ($F = 14.26$, $p < 0.01$). The improvement in sprinting performance at 30 m was 8% for the NGroup ($p < 0.001$) and 6.2% for the HGroup ($p < 0.001$). Similarly, the CGroup presented a limited improvement in running velocity at 30 m from the first to the last measurement (2.1%, $p < 0.001$). Figure 1 illustrates the improvement percentage in 30 m sprint runs in all groups pre, mid and post the eight-week training program.

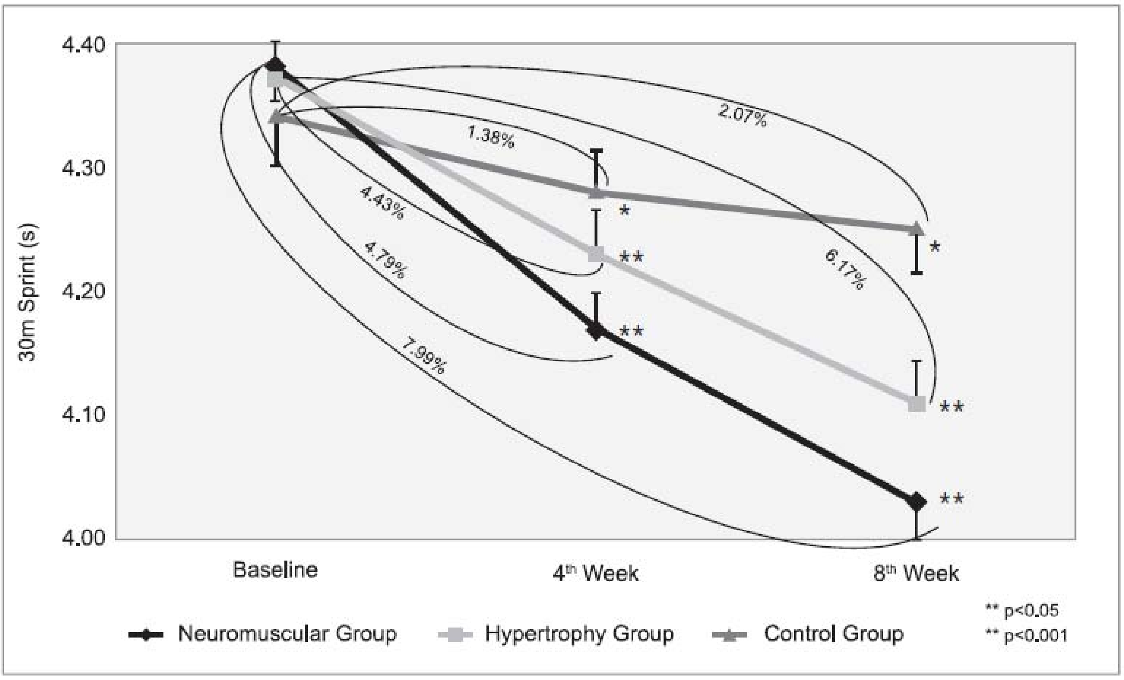

Figure 1. Speed improvement (%) in recorded fastest times at 30 m sprint in each group at the baseline in the 4th and the 8th week of the training program

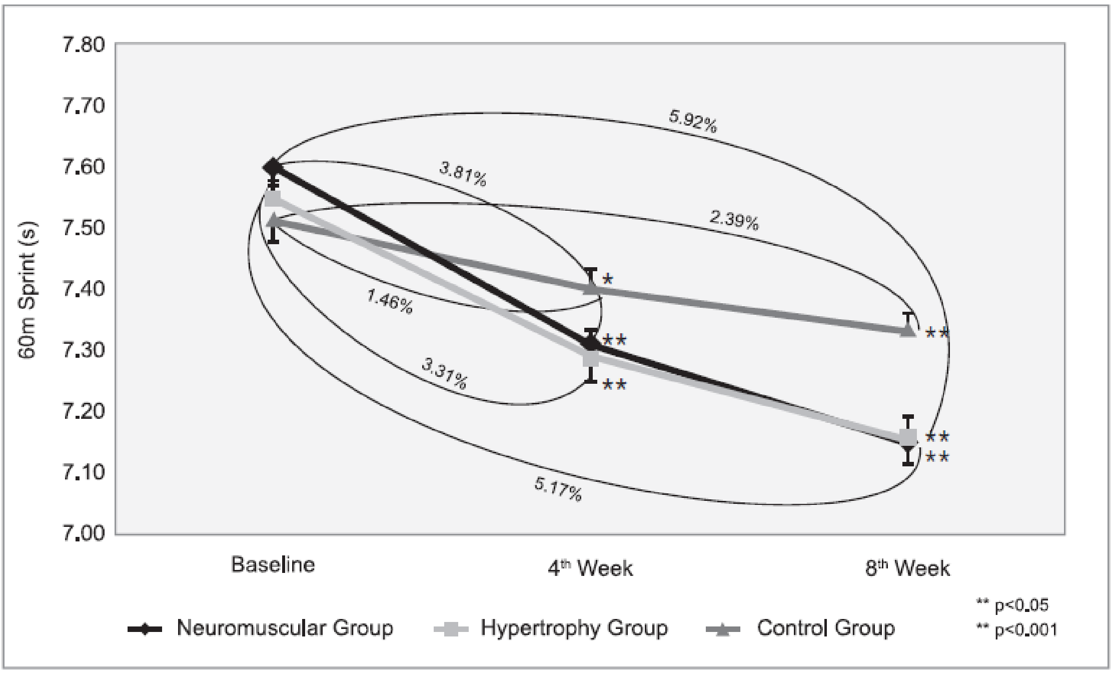

Figure 2. Speed improvement (%) in recorded fastest times in 60 m sprint in each group of athletes at the baseline in the 4th and the 8th weeks of the training program

The inter-group comparisons (Tukey's HSD post hoc) revealed statistically significant differences ($p < 0.05$) in the 1st and 2nd measurements between the NGroup and the CGroup as well as between the HGroup and the CGroup. In addition, the highest difference in speed results was shown in the 1st and 3d testing trials between the NGroup and the CGroup as well as between the HGroup and the CGroup ($p < 0.05$).

60 m sprint

The Analysis of Variance revealed a significant interaction between all groups from the first to the last 60 m measurement ($F = 11.9$, $p < 0.001$). The athletes in both NGroup and HGroup improved their sprinting ability for 5.9% and 5.2%, respectively ($p < 0.001$). Additionally, the improvement at 60 m in the CGroup was marginal (2.4%) between the first to the last testing trial after the 8th week ($p < 0.001$). Figure 2 illustrates the percentage of improvement in 60 m speed in all groups pre, mid and post the eight-week training program.

The inter-group comparisons (Tukey's HSD post-hoc) showed statistically significant differences ($p < 0.05$) in the 1st and 2nd measurements between the NGroup and the CGroup as well as between the HGroup and the CGroup. Similarly to the results of the 30 m runs statistically significant differences in fastest times were recorded between the 1st and the 3rd testing trials in the 60 m runs, between the NGroup and the CGroup as well as between the HGroup and the CGroup ($p < 0.05$).

DISCUSSION

30 m sprint

The study results showed that athletes from the NGroup and the HGroup improved their sprinting performance for 8% and 6.1%, respectively, while in the CGroup the improvement was only 2.1%. At the baseline the greater percentage of speed improvement in the athletes from the NGroup and the HGroup as compared with the CGroup resulted from the strength training program. Thus the intramuscular coordination and hypertrophy strength training programs had a beneficial effect on young sprinters' training profile as revealed in the 30 m sprint trial. Like in some previous research [24, 25] the results of the present study confirm that the improvement in maximal strength combined with coordination and technique can contribute to the athlete's running speed improvement as well to the best time at the initial acceleration phase. Furthermore, maximum strength has a positive and linear relationship with the athlete's acceleration ability to increase speed from the starting position to the attainment of maximum speed. In contrast, other authors [15, 17] support that the maximal strength did not improve the athletes' running speed, claiming that the use of resistance training is not an adequate training method for sprinters, who must exercise predominantly with coordination runs or maximum-velocity sprints. Controversies related to the findings of the above studies [19, 20] led us to state that the combination of maximum-strength training with sprints at the highest intensity is suitable for the development of sprinters' best performance. However, the results of the present study which reported a increasing trend in the NGroup athletes' performance in 30 m trials could have been much higher, had the training period been longer than eight weeks.

60 m sprint

Similarly to the 30 m sprint test, the results of the 60 m trials showed that the eight-week training program produced an improvement in sprinting performance in both NGroup and HGroup for 5.9% and 5.2%, respectively, while in the CGroup the improvement was slight. From the baseline, the greater percentage of improvement in athletes' speed appeared to be in the NGroup as compared with the HGroup and the CGroup. The slighter speed improvement in 60 m trials after the strength training program as compared with the 30 m trials could be explained by the fact that maximal strength is reflected in athletes' acceleration ability (0-30 m), while it has an indirect effect on the maximum-speed phase (30-60 m). However, maximum velocity in relation to acceleration is independent of maximal strength but strongly related to coordination runs or innervation exercises which help the athlete improve the maximum cyclic speed with a high quality of movement technique [26]. Therefore, the nature of the relationship between strength and velocity is related to inter- and intramuscular coordination, which maximizes the speed benefits in the sprinting phase of 30-60 m.

According to sports literature strength and speed are synonymous. The results of the present study show that both the neuro-muscular and hypertrophy strength training programs improve young athletes' sprinting performance. Furthermore, we can state that the above training programs could be more beneficial for young athletes at the distance of 30 m (acceleration phase) rather than in the maximum-speed phase of 60 m. Finally, the greater improvement in speed performance through the neuro-muscular training program in testing trials of 30 m and 60 m can prompt future research on the physiological and neuro-muscular aspects of sprinting.

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