Effect of Short Burst Activities on Sprint and Agility Performance in 11- to 12-Year-Old Boys

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Abstract

Pettersen, SA and Mathisen, GE. Effect of short burst activities on sprint and agility performance in 11- to 12-year-old boys. *J Strength Cond Res* 26(4): 1033–1038, 2012—There are limited data on how coordinative sprint drills and maximal short burst activities affects children's sprint and agility performance. The purpose of the present study was to investigate the effect of short burst activities on sprint and agility performance in 11- to 12-year-old boys. A training group (TG) of 14 boys followed a 6-week, 1-hour·week^{-1}, training program consisting of different short burst competitive sprinting activities. Eleven boys of similar age served as controls (control group [CG]). Pre- and posttests assessed 10-m sprint, 20-m sprint, and agility performance. Results revealed significant performance improvement in all tests within TG ($p < 0.05$), but not between TG and CG in the 10-m sprint test. Furthermore, the relationships between the performances in straight-line sprint and agility showed a significant transfer effect ($r = 0.68–0.75$, $p < 0.001$). Findings from the present study indicate that competitive short burst activities executed with maximal effort may produce improvement in sprint and agility performance in 11- to 12-year-old boys.

Key Words acceleration, sprint training, children, agility testing

Introduction

During the course of development in childhood years, strength, motor skills, and running speed improve (23). The issue of trainability in children has been related primarily to the effects of regular training on the development of aerobic power (1,4,11,16,18,24,27). There are some training studies on adaptability of anaerobic exercise capacity in growing children and adolescents, generally resulting in small increments in performance (2). Most studies have used power production in short-burst activities, conducting Wingate anaerobic power test (30-seconds all-out maximal effort on a cycle ergometer), with peak power (watts) and 30-second anaerobic capacity (kilojoules) as outcome measures (22). There are limited data on how sprint training regimens or sprint and agility drills affect children's sprint and agility performance (23). Mosher et al. (18) reported 20% increase in high-intensity treadmill running in 10- to 11-year-old soccer players after 12 weeks of high-speed activity training. Interestingly there were no changes in 40-yd sprint times. Kotzamanidis (13) showed that a 10-week, twice-per-week, plyometric training program resulted in significantly increased 20- and 30-m sprint velocity, but not 10-m sprint velocity in 11-year-old boys compared with a control group (CG) of similar age.

Buchheit et al. (3) found that 10-week, 1-hour·week^{-1}, repeated shuttle sprints and explosive strength training produced significant improvement in 30-m sprint, but no significant improvement in 10-m sprint in adolescent male elite soccer players. From the existing collection of information, Rowland (p. 207) (23) concludes that it is impossible to say whether children are trainable in short burst activities.

In adults, straight-line speed and agility, the ability to move quickly and change direction while maintaining control and balance (19), have been found to be independent qualities that are specific and produce limited transfer to each other (14,28). Whether children are in line with adults regarding these qualities are not well known.

Both understanding the meaning of and being motivated to work at maximal intensity can be challenging for children. By using competitive activities, you can create more attractive conditions and enhanced motivation and thereby provoke maximal effort in short sprints for this age group (15).

Thus, the main purpose of this study was to investigate the effect of competitive sprint activities, 1-hour·week^{-1} for 6 weeks, on sprint and agility performance in 11- to 12-year-old boys. It is our hypothesis that short straight-line speed and agility performance is trainable and that the stimulation is highly specific to its outcome, in 11- to 12-year-old boys. A key factor is a sufficient intensity level; it means maximal

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Table 1. Physical characteristic data in mean ($\pm SD$) for the training and control groups.*

Physical characteristics	Training group ($n = 14$) Pre	Training group ($n = 14$) Post	Control group ($n = 11$) Pre	Control group ($n = 11$) Post
Age (y)	11.5 (0.3)	11.7 (0.3)†	11.4 (0.3)	11.6 (0.3)†
Height (cm)	154.7 (4.6)	155.3 (4.9)†	153.3 (6.0)	153.8 (5.7)†
Weight (kg)	40.3 (5.3)	40.9 (5.4)†	39.0 (5.3)	39.6 (5.8)†

*No significant differences between groups.
†$p < 0.05$ for pre-posttests within-groups differences.

effort in 2 to approximately 6 seconds. Such knowledge would be of help to coaches and physical education teachers to choose adequate training programs in this age group.

Methods

Experimental Approach to the Problem

The study was designed to investigate whether competitive short burst activities applied on 11- to 12-year-old children would affect sprint and agility performance. One training group (TG) took part in a 6-week, 1-hour·week^{-1}, training program consisting of short burst activities while another group served as CG. Both groups were evaluated through pre- and post-testing of 20-m straight-line sprint (10-m split time) and agility. All participants undertook familiarization trials of the tests before pre- and posttests.

Subjects

Nineteen healthy boys from a local football club, with a mean age of 11.5 years at the beginning of the intervention period, volunteered to participate in the study. Eleven boys, with a mean age of 11.4 years, from the same football club, from the same geographical area and with similar training programs each week served as CG (Table 1). Because both the TG and the CG were selected from a football club, they were not representative samples. Fourteen participants completed 4 or more full training sessions, which was set as inclusion criteria. In addition, the participants undertook two 1-hour club training sessions per week, exclusively devoted to football training (i.e., technical or tactical). Four of the boys in the TG and 5 in the CG were engaged in other organized sport activities. Written informed consent to participate in the study was obtained from both children and their parents in the TG and the CG. The study was given institutional ethical approval.

Test Procedures

The test and training sessions were carried out in a gym on parquet floor and with a stable temperature of 20°C. Pre- and posttests for both groups were performed on the same weekday in the afternoon.

Performance testing started after 12 minutes of supervised warm-up including skipping exercises, sprint drills, and 2 practice sprints in the test courses at about 95% of maximum speed. The participants were instructed to conduct

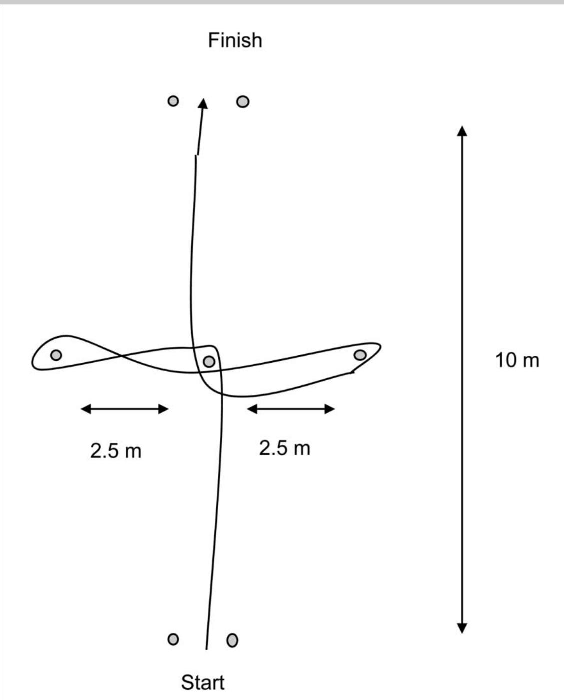

Figure 1. Diagram of the course used in the agility test consisting of two 5-m straight-line sprints, one 5-m slightly curved sprint, and two 2.5-m straight-line sprints.

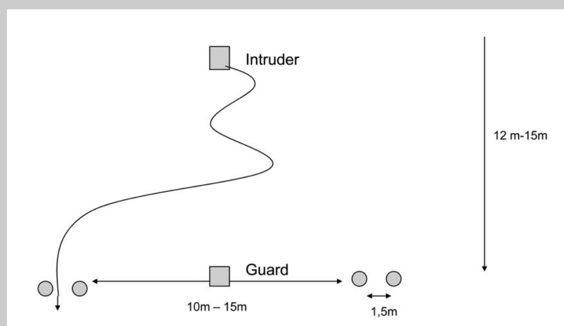

Figure 2. An intruder feints and sprints through 1 of 2 gates while the guard tries to stop him (touch him).

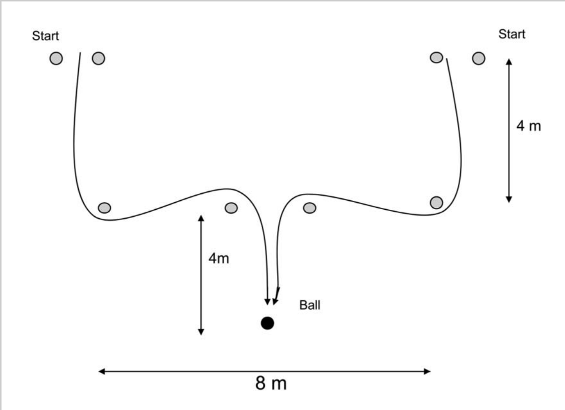

Figure 3. Starting on a signal, 2 competitors run an inverted course competing to be the first to reach the ball.

the tests with maximal effort, but no verbal encouragement was given during the tests. All tests were performed wearing shorts and T-shirt. The same pair of shoes was used in both pre- and posttests to minimize differences in friction between floor and shoes. Electronic timing gates, wireless connected with a timer, were used to record split and completion times (Brower Timing System, Salt Lake City, UT, USA). The sprint test consisted of a 20-m track with 10-m split time recording.

The rear foot was placed on a touch pad starting the timer when the foot was released. The photocells placed at 100-cm height were positioned at 10 and 20 m in the straight-line sprint test and at the finish line in the agility test. Standing starting position was freely chosen, and each participant performed 2 trials of each test with at least 3 minutes of rest between trials.

The agility test course was 20 m, starting with 5-m straight-line sprint followed by a 90° turn, 2.5-m straight-line sprint followed by a 180° turn, 5-m slightly curved sprint followed by a 180° turn, 2.5-m straight-line sprint followed by a 90° turn and 5-m straight-line sprint (Figure 1). Three 120-cm-high coaching sticks, which were not allowed to be touched, were used to ensure correct passage in the turns. The best performances in each test were used for analysis.

Table 3. Test-retest reliability coefficients (intraclass correlation) and *SEM* values in sprint and agility tests in the control group ($n = 11$).*

Test	*ICC*	*SEM*	*p* value
10-m sprint	0.92	0.05	<0.05
20-m sprint	0.91	0.10	<0.05
Agility	0.87	0.26	<0.05

*ICC = intraclass correlation.

Training Program

Each 1-hour session of the 6-week training program consisted of 10 minutes of warm-up including coordinative sprint drills followed by different competitive sprinting activities, e.g., relays with 90° and 180° turns, an "intruder" feints and sprints through 1 of 2 gates 10–15 m apart while a "guard" tries to touch him when passing through the gates (Figure 2). Standing face-to-face feinting to run right or left while an opponent tries to catch you once 1 foot is released from the floor. Two opponents start on signal and run an inverted course competing to be the first to kick a ball placed at the end of the course (Figure 3). Work periods did not last longer than approximately 5 seconds with a constant focus on executing all competitions or exercises with maximal effort during the training sessions.

Every exercise period was followed by a 25 times longer rest or very low activity period, e.g., 4 seconds exercise = 100 seconds rest or very low activity resulting in a training volume of approximately 30 sprints each training session.

Statistical Analyses

Two-tailed independent *t*-test was used to analyze differences in anthropometrics and performance between the TG and the CG and change in performance from pre- to posttests between groups. Two-tailed paired *t*-test was applied to analyze changes in anthropometrics and also changes in sprint and agility performance between pre- and posttests within both groups. The relationships between performances in sprint and agility tests were determined by

Table 2. Pre- and posttest results for sprint and agility in mean (±*SD*) for the training and control groups.*

	TG ($n = 14$)		CG ($n = 11$)	
Test	Pre	Post	Pre	Post
10-m sprint (s)	2.29 (0.12)	2.24 (0.11)†	2.30 (0.12)	2.27 (0.12)
20-m sprint (s)	3.96 (0.20)	3.89 (0.18)†‡	3.95 (0.20)	3.97 (0.24)
Agility (s)	8.50 (0.38)	8.21 (0.31)†‡	8.56 (0.39)	8.61 (0.41)

*TG = training group; CG = control group.
†$p < 0.05$ for pre-posttests within-group change in performance.
‡$p < 0.05$ for pre-posttests between-groups change in performance.

Table 4. The relationships between the performances in straight-line sprint and agility in the training and the control group ($N = 25$).

Relationship assessed	Pearson's r	r^2	p value
10-m sprint vs. agility	0.68	0.46	<0.001
10-m sprint vs. 20-m sprint	0.92	0.85	<0.001
20-m sprint vs. agility	0.75	0.56	<0.001

Pearson's correlation (r). The same procedure was used to detect any correlation among sprint, agility, and anthropometrical variables. One-way analysis of variance, using 1-way random effects model, was applied to calculate intraclass correlation (ICC) between test-retest in the CG. All analyses were performed using SPSS v.17.0 (SPSS, Inc., Chicago, IL, USA). The accepted level of significance was set at ≤0.05.

Results

At the start of the training period, there were no significant differences between the TG and the CG regarding height, weight, sprint performance, or agility (Tables 1 and 2). Compared with the CG, the TG showed significantly better performances in both 20-m sprint and agility after the training period, but not in 10-m sprint (Table 2). The CG (Table 2) did not show any significant pre-posttest change in performance ($p < 0.05$). Table 3 shows the ICC and *SEM* between test and retest of each dependent variable in the CG. No significant correlations between height and performance were found. There were significant correlations ($p < 0.001$) between 10-m ($r = 0.68$) and 20-m ($r = 0.75$) sprint times and agility. There was also a strong correlation between 10- and 20-m sprint times ($r = 0.92$) (Table 4).

Discussion

In this study, the participants performed short burst competitions or activities with maximal intensity 1 hour a week in 6 weeks. The main finding was that both agility and 20-m sprint performance improved significantly in the TG but not in the CG.

The largest improvement in performance was found in agility (3.5%) compared with acceleration (2.1%) and speed (1.8%) (Table 2). This may result from the conditioning program design consisting of short maximal acceleration and deceleration activities with change in direction followed by new accelerations. It is claimed that improvement in agility comes through developing these movement patterns (7). Neuromuscular adaptations related to firing frequencies and improved coordination are likely to have occurred in the TG, which could have improved the ability to rapidly and forcefully accelerate and decelerate (21,23). Hamstra-Wright (9) found that skilled prepubertal children had lower coactivation in the landing phase of a drop jump than nonskilled prepubertal children. The forceful deceleration in some of the training activities shares many of the same neuromuscular challenges as the landing phase in a drop jump. Most likely the performance improvement in the TG is mainly caused by neuromuscular adaptations indicating that sprint training to a larger extent than aerobic training will have a more permanent effect in growing children because the neural system is still not fully matured.

Oxyzoglou et al. (20) found significantly better agility test results in preadolescent boys engaged in 6-months, 3-hours·week^{-1}, specific handball training compared with a mainstream physical education program. The authors indicate that the training staff might have contributed to the above-described differences owing to the greater emphasis placed on training load in the handball TG. Unfortunately, there were no agility pretests. The 3.5% improvement in agility in the present study after 6 hours of short burst activities may partly be explained by the experienced training staffs' emphasis put on executing maximum effort in every activity, in addition to the competitive structure of the activities, resulting in training specific performance improvement. It could be argued that the performance improvement in agility is a result of the training activities, which include elements of the test (90° and 180° turns), but it is almost impossible to create agility exercises without short burst acceleration and deceleration activities with change of direction.

In 20-m straight-line sprint, the TG experienced significant improvement after the training period, whereas there were no significant changes in sprint times in the CG. No running activities in the training period had longer straight-line sprints than 10–12 m, implying that little or no maximum speed training were conducted during the training period, which may partly explain the rather weak improvement (1.8%) in 20-m straight-line sprint. Venturelli et al. (26) only achieved slightly better improvement (2.4%) in 11-year-old soccer players in a 12-week training program consisting of 20 repetitions of 10- and 20-m maximal sprints twice a week.

There were no significant differences between groups in 10-m sprint after the training period, although the improvement was significant within the TG. All the participants were unfamiliar with the starting procedure, resulting in much focus on maintaining the pressure to the touch pad. This may partly explain why there were no significant differences in acceleration between groups. In agreement with the present findings, Kotzamanidis (13) and Buchheit et al. (3) found no significant difference between the TG and the CG in 0- to 10-m sprint in 11- and 14.5-year-old boys after a training period. Immature starting technique may have caused the results, although Kotzamanidis and Buchheit et al. used electric timing gates to start the timer, which theoretically should simplify the starting procedures compared with using a touch pad.

The typical recommendations for young athletes engaged in sprint activities are 2 or 3 training sessions per week (8,17). The boys in the present study had not been exposed to sprint training earlier, which could have contributed to the positive response to only 1 hour·week^{-1} sprint activities. On the other hand, it should be taken into consideration that the children performed approximately 30 sprints or agility runs each training session, which is a substantial training volume. Further studies are needed to investigate whether more training hours per week will increase the positive effect and if less than an hour devoted to sprint activities will be enough to produce performance improvement.

According to new Norwegian growth charts, the 50th percentile for weight and height in 11.5-year-old boys are 40 kg and 150 cm, respectively (12). The boys in the present study were somewhat taller than average boys of the same age (Table 1). Body height is considered a factor that indirectly affects speed through the stride length. Significant increase in height in the TG may have contributed to the improvement in speed. On the other hand, the CG also became significantly taller without any change in sprint performance. Both groups also had a small, but significant increase in weight, which may partly explain why the CG increase in length did not produce an increase in acceleration and speed. The weak correlation between height and acceleration ($r = 0.17$), height and speed ($r = 0.19$), and height and agility ($r = -0.18$) (Pearson) indicates that height does not explain differences in acceleration, speed, or agility among the participants ($N = 25$).

In the present study, straight-line sprint and agility were correlated at high levels of significance ($p < 0.001$), suggesting that they share common physiological and biomechanical determinants, thus implying a transfer effect to each other. The 10-m sprint and agility share 46% common variance, whereas in 20-m sprint and agility, the common variance is 56% (Table 3), indicating that if you are fast in straight-line sprint you will have an advantage in agility. The correlation between straight-line sprint and agility in the present study is stronger than found among adults (5,14,28).

Standards of duration of maximal intensity and rest periods to improve short burst fitness are not as clearly defined as for aerobic fitness, especially when it comes to children. It has been suggested that children recover faster from sprint exercise than adults (6). Children (10.3 ± 1.4 years) are more highly dependent on oxidative metabolism and therefore rely less on glycolysis than young adults (21.6 ± 1.6 years) during maximal repeated sprint. Children also have less to "recover from" because of minor muscle mass than adults (10). In addition, phosphocreatine resynthesis has been reported to be faster in children than in young adults (25). Taking into consideration these child-adult differences, exercise time (seconds) was interspersed with 25-times rest periods or very low intensity periods, which is considerably shorter than recommended for adults performing sprint training.

Practical Applications

This study highlights that 1-hour sprint competitions or activities per week reveal improvements in both sprint and agility beyond what could be explained by growth and maturation. Designing training programs with competitive activities can create more attractive conditions, which may lead to enhanced motivation and thereby provoke maximal effort in short sprints for this age group. By organizing the training sessions with short burst competitions lasting 2–5 seconds, interspersed by 1- to 2.5-minute recovery time between the sprint periods, you will get a substantial training volume in 1 hour. Short burst activities executed with maximal effort ought to be a part of every general conditioning program in children because the neural system is still not fully matured and therefore the neuromuscular adaptations to the training can have some permanent effect.

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