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Effects of Uphill Training on Biomechanical Variables of Speed, Acceleration and Stride Rate among Under – 17 Athletics Project Trainees

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Abstract

This study attempted to explore the effects of uphill training on biomechanical variables of speed, acceleration and stride rate among under -17 athletics project trainees. To meet the objectives of this study, 24 female and male athletes aged 15 to 16 years from under -17 project trainees were selected as subjects. The subjects were divided in to two groups with equal number of male and female participants, in which group - I were control (N = 12 participants) training group and group II – were experimental (n = 12 participants) training group. There was no variation in intensity, load, duration and type of the training during the study. Both experimental and control groups were tested before and after the eight weeks of experimental program. The physical fitness variables selected for the study were: speed, acceleration and stride rate. Data were analyzed by using SPSS paired samples t- test with pair wise comparison of means at 95% confidence interval by using pre and post- tests. There were significantly improvements on speed, acceleration and stride rate due to the effects of uphill training program.

Keywords: Uphill training, Sprinter, Speed, Acceleration, Stride rate, Biomechanics.

Introduction

Today, it is an era of minimum input and maximum output for this every possible work is being done to increase efficiency by scrutinized research so that, sportsmen can get maximum biomechanical advantage to improve their performances [4]. Speed plays a vital role in all sports but it plays a very dominant role especially for the sprinters. For a sprinter to give good performance who must possess acceleration speed, sprinting speed, speed of movement and reaction time[1]. Each sprinter has an individual speed dynamics shown in different combinations of stride frequency and stride length, acceleration capacity, ability to relax etc. These individualities depend largely on genetic differences, as well as physical development and training levels of an athlete[8].

It has been suggested that when running on level surfaces runners use technique optimized for minimal metabolic cost; however, when the inclination of the surface is altered runners will modify mechanical variables to achieve optimal metabolic efficiency. Previous research has revealed that uphill running is associated with greater energy expenditure[6] and increases in step frequency and decreases in ground reaction forces (GRF) [5]. The ability to efficiently accelerate and reach maximum running velocity is essential for athletic success. Training for enhanced speed is a key element in most strength and conditioning programs and typically develops two essential components of speed: acceleration and velocity. Acceleration is defined as the rate of change in velocity and is often measured by assessing sprint performance over short distances. Velocity refers to the rate of movement over a specified distance and is commonly measured by meter [2, 7]. Improved acceleration and velocity is achieved by increasing the physical, metabolic and neurological components associated with sprinting[3].

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Methodology

Subjects

Radom sampling technique was used to select 24 participants (with both sexes) of the total population aged from 15 -16 years old for the study and also those participants were divided into two groups i.e. the experimental group (n = 12) and the control group (n = 12) for eight weeks training program. The design for the study was experimental design, pre and post training tests were conducted for the two groups. The experimental group was participated in uphill training program but the control group involves at track with no variation in intensity, duration, frequency and type of exercise. The training was given at 85 - 95% MHR intensity by the investigator for 8-weeks of 3 days per week for 40 minutes.

Variables and tests

Table I The Selected Variables and their Tests

Variables	Tests	Criteria's to be measured
Speed/velocity	50 meter dash, 15 -20m acceleration zone and 30m (30-meter fly test) with 95-100% intensity	Second
Acceleration	30-meter timing zone, beginning from an upright, standing start. The watch should be started from the instant the rear foot leaves the ground and stopped when the torso crosses the end of the timing zone	Second
Stride rate	50 meter dash, count the number of strides per time	Numbers

Procedures

The experimental and control groups were includes both male and female participants aged between 15 – 16 years old from under -17 athletics project trainees. Both groups were tested their speed, acceleration and stride rate before and after the eight weeks training program. The experimental group (n = 12) were involved in uphill training for eight consecutive weeks whereas the control group (n = 12) were conducted their training at the track or level ground. The training intensity, load, duration and type of exercise were the same for those two groups but the only difference is the place or area they train. The data collected on pre-test and post-test were subjected to further statistical analysis for interpretation.

Training program

This uphill training program was given for eight consecutive weeks with a frequency of 3 days in a week with durations of 40 minutes per session (i.e. 8 minutes warm-up, 20 minutes of the main session, 5 minutes of cool down and totally 7 minutes for active rest among intervals).

Table II. Training Program of the Study

Week	Program	Repetition and Set	Recovery	Load %MHR
1 - 8	**Drills for speed.** • Ankling • High-Knee • Butt-Kick • Straight-Leg Shuffle • 30m full speed	20 m×4×1 20m×4×1 20m×4×1 20m×3×1	Active recovery (Walk back) 2' between drills.	60 -80%
		60m dash×3×2	2`,3`	80–100%
	Exercise for stride rate ✓ Running with ball of feet ✓ Skipping ✓ hopping	30m ×3×2 30m ×3×2 20m ×3×1	2`, 3` 1`,2` Walk back	50 -70%
	Exercise for acceleration ✓ Acceleration ladder ✓ Resisted running	30m ×3×2	1',3'	85 -90%
		50m ×3×2	2',3'	60 – 80%

Statistical Analysis

Data were analyzed by using SPSS paired samples t- test with pair wise comparison of means at 95% confidence interval by using pre and post- tests. This was used as statistical tool to find out the significant differences between the experimental and control group on selected criterion variables separately. Level of significance was set at 0.05 ($p < 0.05$) levels for testing the significance of statistical interpretation.

Results

To investigate the effect of uphill training on biomechanical variables of speed, acceleration and stride rate among the under-17 athletics project trainees. The experimental groups were participated in uphill training program for eight weeks with the frequency of 3days/week and 40 minutes per session. The selected physical fitness variables were measured two times: pre and post training test and the trainees were divided into control and experimental groups randomly. The variables which were measuring for the study were speed, acceleration and stride rate. The data was analyzed through paired t-test. The results for each variable were discussed as follow:

Table III. The pre and post training test results for the selected variables of these female control and experimental groups (Mean ± SD).

Dependent Variables	Group	PT	PoT	Sig.
Speed	Control	6.00 ± 0.12	6.13 ± 0 .16	0.03*
	Experimental	5.98 ± 0.09	6.22 ± 0 .15	0.02*
Acceleration	Control	1.19 ± 0.04	1.25 ± 0.07	0.03*
	Experimental	1.20 ± 0.05	1.29 ± 0.06	0.03*
Stride rate	Control	3.89 ± 0.21	3.95± 0.34	0.04*
	Experimental	3.92 ± 0.18	4.48 ± 0.38	0.01*

P < .05 * = *Significant and the data in the form of Mean ± SD (standard deviation).*

Table 3 shows that there was significantly improvement in performance on speed, acceleration and stride rate among the under-17 athletics project female trainees. The pre training test mean values for speed, acceleration and stride rate were 5.98± 0.09, 1.19 ± 0.04 & 3.89 ± 0.21, (control group) and 6.00 ± 0.12, 1.20 ± 0.05 & 3.92 ± 0.18 (experimental group) respectively. But after the delivery of eight weeks training test mean values for speed, acceleration and stride rate was 6.13 ± 0 .16, 1.25 ± 0.07 & 3.95± 0.34, (control group) and 6.22 ± 0 .15, 1.29 ± 0.06 & 4.48 ± 0.38 (experimental group) respectively.

Table IV. The paired differences of both the female control and experimental groups

Dependent variables	Groups	
	Control group	Experimental group
Speed (m/s)	0.15 m/s	0.23 m/s
Acceleration (m/s^2)	0.06 m/s^2	0.10 m/s^2
Stride rate (strides/sec)	0.06 strides/sec	0.56 strides/sec

The pre and post training tests shows that there was a significant difference in the speed, acceleration and stride rate (mean difference was 0.15 m/s, 0.06 m/s^2 & 0.06 control group and 0.23 m/s, 0.10 m/s^2 and 0.56 strides/sec experimental group). The above statistical analysis indicates that there was a significant improvement in speed after the eight weeks of training period. Experimental groups shows 0.7 m/s, 0.04 m/s^2 and 0.50 stride/sec greater speed, acceleration and stride rate respectively than control group. Table IV indicates that the female experimental group was shows significantly an improvement in speed, acceleration and stride rate than the female control group. So, this increment was predominantly showed due to the biomechanical effect of uphill training because the groups which were done their training on hill (the female experimental group) shows absolute change in speed, acceleration and stride rate than the athletes were performing their training at the track (the female control group).

Table V. The pre and post training test results for the selected variables of these male control and experimental groups (Mean ± SD).

Dependent Variables	Group	PT	PoT	Sig.
Speed	Control	6.19 ± 0.39	6.31 ± 0 .45	0.00*
	Experimental	6.61 ± 0.37	6.94 ± 0 .38	0.01*
Acceleration	Control	1.28 ± 0.16	1.33 ± 0.20	0.00*
	Experimental	1.41 ± 0.15	1.61 ± 0.18	0.02*
Stride rate	Control	4.41 ± 0.30	4.60 ± 0.35	0.30*
	Experimental	4.23 ± 0.22	4.93 ± 0.25	0.05*

P < .05 * = *Significant and the data in the form of Mean ± SD*

Table V shows that there was significantly improvement in performance on speed, acceleration and stride rate among the under-17 athletics project male trainees. The pre training test mean values for speed, acceleration and stride rate was 6.19 ± 0.39, 1.28 ± 0.16 & 4.41 ± 0.30, (control group) and 6.61 ± 0.37, 1.41 ± 0.15 & 4.23 ± 0.22 (experimental group) respectively. But after the delivery of eight weeks training test mean values for speed, acceleration and stride rate was 6.31 ± 0 .45, 1.33 ± 0.20 & 4.60 ± 0.35, (control group) and 6.94 ± 0 .38, 1.61 ± 0.18 & 4.93 ± 0.25 (experimental group) respectively.

Table VI. The paired differences of both the male control and experimental groups

Dependent variables	Groups	
	Control group	Experimental group
Speed (m/s)	0.08 m/s	0.60 m/s
Acceleration (m/s^2)	0.03 m/s^2	0.27 m/s^2
Stride rate (strides/sec)	0.19 strides/sec	0.70 strides/sec

The pre and post training tests shows that there was a significant difference in the speed, acceleration & stride rate (the mean difference was 0.12 m/s, 0.05 m/s^2 & 0.19 strides/sec for control group and 0.33 m/s, 0.20 m/s^2 & 0.70 strides/sec for experimental group) among the two groups. The above statistical analysis indicated that there was a significant improvement in speed, acceleration and stride rate after the eight weeks of training period. Therefore, experimental group shows 0.21 m/s, 0.15 m/s^2 & 0.51 stride/sec greater speed, acceleration and stride rate respectively than control group due to the biomechanical advantages of the uphill training. Table VI indicates that the male experimental group was shows significantly an improvement in speed, acceleration and stride rates than the male control group due to the uphill training program. Generally, the above statistical analysis indicates that both male and females experienced a better performance enhancement on the speed, acceleration and stride rate than the control group. Thus, the data interpretation showed that 95% Confidence Interval of the Difference in response to the biomechanical effects of uphill training.

Discussion

Based on the obtained results, it has been observed that there was a significant improvement in speed, acceleration and stride rate due to the biomechanical effects of uphill training. The experimentation was conducted for eight consecutive weeks which includes the experimental and control groups to investigate the uphill training effects on speed, acceleration and stride rate. The analyses of data were done through paired t-test to see the difference and the level of significance was set at 0.05. The test results show that statistically significance enhancement observed in the participant's speed, acceleration and stride rate. Therefore, athletes participating in uphill training (the experimental group) were achieved a greater performance in speed, acceleration and stride rate than athletes that performs training at the track (control group).

Biomechanically running uphill forces the athletes to run with shorter strides to keep the center of gravity of the body, helps to run with feet, to lean forward slightly, to add an additional load on the body specially the lower body parts, to coordinate the leg hand movements etc. all these biomechanical effects of uphill training helps an athlete to run with the basic running techniques of sprinting especially the speed and acceleration. This study supports the study of entitled biomechanical basis of human movement by (Hamill & Knutzen, 2009). Running velocity can be increased by increasing stride length, stride rate, or both. At higher speeds, SL can only increase so much due to anatomical limitations, but SR can continue to increase as the athlete learns to run more efficiently and makes greater gains in strength, power, and flexibility. Thus, the uphill training can have an effect on the stride rate of the sprinter simultaneously stride rate affects the speed and acceleration of an individual athlete.

Conclusion

Based on the results of this investigation, it can be concluded that;

1. Uphill training helps the athlete to increase stride frequency, muscular force output (especially at the hip, knee, and ankle) and the speed & acceleration as well. This indicates a high level of fast force production in top sprinters and reaffirms the importance of strength during the acceleration phase of sprinting which, one can get through resisted speed training or uphill training.
2. Biomechanically uphill training program affects the speed of an athlete; this was due to the finding that uphill running supports the athlete to run with short strides, helps to run with ball of feet and forced to lean forward, in order to keep the body center of gravity. These all biomechanical advantages give an opportunity for athlete to run fast with a speed at track.
3. As speed of the athlete increases through the positive results of the uphill training this increment in the performance of speed directly affects the acceleration of the athlete. While train in the uphill the athlete responses to the stimuli that were occurring due to the uphill training program effects and this helps the athlete body to adapt the situation and to perform an exercise out of these stimulus (at a track).
4. Biomechanically uphill training affects the performance of an athlete by improving the stride rate. One of the biomechanical effects of uphill training program was forced to decrease in stride length due to the resistance which applied on the athlete; this can also helps the sprinter to develop the techniques of running fast by reducing the contact time between the leg and the ground, and increasing the stride rate at a track.

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