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APPLICATION OF A MULTI-JOINT PUMPING METHODOLOGY IN IMPROVING THE RUNNING TECHNIQUE OF SHORT-DISTANCE STUDENT-ATHLETES AND ITS EFFECT ON SPORTS PERFORMANCE

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Abstract

This article presents a comprehensive scientific and practical analysis of a multi-joint pumping training methodology aimed at improving the technical preparedness of student-athletes specializing in short-distance running. The study examines the content, application characteristics, and performance effects of the proposed methodology. Particular attention is given to the effectiveness of multi-joint pumping exercises in developing the major muscle groups involved in the start, block clearance, acceleration, maximal velocity, and finishing phases of sprinting. The findings demonstrate that the systematic application of multi-joint pumping significantly enhances biomechanical efficiency, neuromuscular coordination, and sprint performance indicators among student-athletes.

Keywords: Short-distance running, technical preparation, multi-joint pumping, start technique, stretch reflex, running cadence, stride length, student-athletes, sports performance, athletics.

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Introduction

Multi-joint pumping is a training method designed to prepare the athlete's body for performing high-intensity workloads within a short period of time. Its primary advantage lies in the simultaneous activation of multiple joints, which enables efficient energy transfer, reduces unnecessary energy expenditure, and optimizes time efficiency during sprint movement from start to finish. Consequently, this method not only develops speed-strength, speed endurance, and special endurance, but also improves postural muscle function, balance maintenance, and adaptability to rapidly changing competitive conditions.

For short-distance runners, the application of large-amplitude and high-intensity pumping exercises is particularly recommended. These exercises are typically performed for 5–10 seconds, with the number of repetitions determined by the athlete's level of preparedness, and at an execution intensity of 95–100% of maximal speed. Under such conditions, the athlete's body operates predominantly in an anaerobic regime, with maximal heart rate responses and energy expenditure.

In contrast, middle-distance runners are advised to perform moderate-amplitude and moderate-intensity pumping exercises (15–30 seconds at 70–80% intensity), which stimulate mixed aerobic–anaerobic energy systems. Long-distance runners benefit most from low-amplitude, low-intensity pumping exercises (30–60 seconds at 60–70% intensity), predominantly engaging aerobic mechanisms.

From a structural perspective, pumping exercises are classified as follows:

- **Simple pumping:** involvement of 1–3 joints;
- **Complex pumping:** involvement of 4–6 joints;
- **Multi-joint pumping:** involvement of 6 or more joints.

The versatility of multi-joint pumping, performed with varying amplitudes and intensities, makes it an effective tool for the functional development of athletes, particularly during sprint-specific movement patterns such as the block start and initial acceleration.

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Start Technique in Short-Distance Running

In short-distance running, three primary block start techniques are commonly distinguished:

1. **Bunched start**,
2. **Medium start**,
3. **Elongated start**.

According to modern athletics competition regulations, starting blocks are equipped with false-start detection systems that allow a maximum force of up to 30 kg to be applied after the "Set" command without constituting a rule violation. This regulatory change necessitates adaptation to new start technique requirements and the development of innovative methodological approaches.

Bunched Start

In the bunched start, the starting blocks are positioned closer to the starting line, resulting in a more compact body configuration. While this may be advantageous for some athletes, it often creates discomfort for taller or more heavily built sprinters. In the "Set" position, approximately 50% of body weight is transferred to the shoulders, forearms, and elbows, with the pelvis positioned higher than the shoulder level. This configuration allows for longer initial strides during block clearance and facilitates the selection of an optimal running cadence during acceleration.

Medium Start

The medium start is individually adjusted based on the athlete's anthropometric characteristics and is generally perceived as the most comfortable configuration. Compared to the bunched start, less body weight is transferred to the upper limbs, while load distribution across the hip, knee, and ankle joints is more balanced. However, the initial stride tends to be shorter, and the push-off angle during block clearance is typically around 45 degrees.

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Elongated Start

The elongated start is most commonly used by taller athletes and involves positioning the blocks farther from the starting line. In this configuration, body weight in the "Set" position is primarily distributed across the pelvis, hips, knees, and ankles, while the shoulders, elbows, and hands serve as stabilizing supports. The force applied to the starting blocks is generally below 30 kg, reducing the likelihood of false starts. This technique enables tall athletes to achieve an effective and controlled start.

Taking these biomechanical considerations into account, a multi-joint pumping methodology was developed to adapt student-sprinters to modern competition requirements and to improve start and acceleration technique.

Biomechanical Rationale and Stretch Reflex Development

Elite sprinters must maintain optimal trunk alignment relative to the running track to achieve and sustain maximal velocity. Efficient sprinting requires rapid and forceful hip extension under the body's center of mass. Excessive forward trunk lean at maximal speed increases energy expenditure for balance maintenance, disrupts optimal force application, and leads to heel-dominant ground contact, ultimately reducing sprint performance.

To address this issue, the proposed methodology emphasizes the development of the stretch reflex in the hip–knee–ankle complex. A specialized training system targeting stretch reflex enhancement was developed and implemented in practice.

Structure of the Multi-Joint Pumping Training Methodology

1. Low-Amplitude Exercises

Exercises focusing on ankle, knee, and hip extension to enhance stretch reflex responsiveness:

- Rapid plantarflexion and dorsiflexion movements for 10 seconds in a seated 90-degree knee position (10 repetitions, interval rest method);
- Alternating ankle push-offs in place without knee or hip flexion (50 repetitions per foot, 4 sets);

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• Alternating ankle push-offs with forward movement (50 repetitions per foot, 4 sets).

These exercises effectively develop the ankle, knee, and hip joints, which are essential for sprint start, acceleration, and maximal velocity phases.

2. Moderate-Amplitude Exercises

• Alternating knee lifts to moderate height with single, double, or quadruple push-offs per step;

• Progressive and regressive push-off sequences (1–2–3–4 and reverse).

Each exercise is performed for 20 repetitions per leg, with 30-second rest intervals.

3. High-Amplitude Exercises

• Vertical jumps with bilateral take-off and hand-supported landing;

• Single-leg jumps with alternating leg execution;

• Complex jump sequences combining squats, dynamic lunges, and vertical jumps;

• Sprint-position jumps with mid-air limb exchange.

All exercises are performed at high intensity, with 10 repetitions and 1-minute rest intervals.

• At the final stage of the study, the technical preparedness of short-distance student-athletes was assessed based on key biomechanical and performance indicators, including stride length, running cadence, number of steps, running velocity, and time required to complete the sprint distance.

- Performance indicators of short-distance student-athletes:

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100 m sprint time	Time required to cover the initial 10 m distance	Stride length	Running cadence (steps·min^{-1})	Total number of steps over the 100 m distance
11,45	1,15	1,95	235,81	51,2
11,32	1,13	1,97	238,52	50,7
11,29	1,13	2,01	239,15	49,8
11,24	1,12	2,01	240,21	49,7
11,34	1,13	1,95	238,1	51,2
11,20	1,12	2,02	241,07	49,6
11,18	1,12	2,00	241,50	50,1
11,36	1,14	1,93	237,68	51,9
11,24	1,12	1,95	240,21	51,2
11,29	1,13	1,97	239,15	50,7
11,33	1,13	1,98	238,31	50,6
11,22	1,12	2,01	240,64	49,8
11,41	1,14	1,95	236,63	51,2
11,36	1,14	1,96	237,68	51,1
11,35	1,14	1,98	237,89	50,5
11,28	1,13	1,95	239,36	51,4
11,33	1,13	1,99	238,31	50,3
11,27	1,13	1,98	239,57	50,4
11,35	1,14	1,96	237,89	51,0
11,34	1,13	1,99	238,1	50,3
11,3	1,13	1,99	238,94	50,2
11,31	**1,13**	**1,98**	**238,8**	**50,6**
0,07	**0,01**	**0,02**	**1,42**	**0,630**

Results and Discussion

To evaluate the effectiveness of the proposed methodology, a pedagogical experiment was conducted assessing stride length, running cadence, step count, running speed, and time to cover sprint distances. The results demonstrated consistent improvements across all measured parameters, including reduced 10 m split times, increased stride length, optimized cadence, and a reduced number of steps over 100 m.

The final analysis confirmed that the multi-joint pumping methodology significantly enhances technical preparedness across all sprint phases—start, block clearance, acceleration, maximal velocity, and finish—while promoting

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the development of upper and lower limb musculature. As a result, student-athletes achieved measurable improvements in competitive sprint performance.

Conclusion

The findings of this study provide strong evidence that the systematic application of a multi-joint pumping methodology is an effective means of improving sprint technique and performance in short-distance student-athletes. The methodology facilitates neuromuscular efficiency, biomechanical optimization, and compliance with modern competition requirements, thereby contributing to sustainable performance enhancement.

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