Kinematic Differences Between Land and Shallow-Water Sprinting
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Abstract

Although numerous studies have been completed on the physiology and biomechanics of deep water running, there is a paucity of studies that focus on shallow water sprinting. Thus, the purpose of our study was to compare lower extremity running kinematics of female college athletes in a shallow water sprinting environment and in a land-based sprinting environment.

Background

Previous studies have demonstrated that deep water running can be used as an alternative or supplemental exercise to a training program (1). While dramatically decreasing the impact forces that individuals experience on land, this aquatic running style mimics the movement pattern of running that is found on land (1). Additionally, aquatic running has been shown to produce beneficial physiological effects that are comparable to land-based running (2).

Purpose

Although numerous studies have been completed on the physiology and biomechanics of deep water running, there is a paucity of studies that focus on shallow water sprinting. Thus, the purpose of our study was to compare lower extremity running kinematics of female college athletes in a shallow water sprinting environment and in a land-based sprinting environment.

Materials & Methods

This study was approved through the Linfield College IRB prior to data collection. All participants completed health history paperwork and signed an informed consent. All participants wore a job bracelet, spandex, as well as aquatic training shoes for traction during aquatic trials and exercise clothes e.g. shorts & t-shirt for land trials. Participants were selected based on gender, sport, and running technique. In doing so, this study consisted of 15 female NCAA DIII athletes whom participated in either soccer or track and field. The mean age among the participants was 19.20 years (±5.94), the mean height was 163.97 cm (±5.59), the mean weight was 60.75 kg (±5.89), and the mean body fat percentage was 22.33% (±5.45).

Familiarization

Sterotypically people adopt a drive style, which looks similar to high knees on land. Although this style feels like land sprinting, it does not adequately mimic what we do on land. Thus, a familiarization session on proper water sprinting form was necessary prior to data collection. Each participant was required to complete a shallow water familiarization session. This session covered proper sprinting technique in chest deep water.

In order to mimic sprinting on land as closely as possible we suggest that hip flexion ≥90° perpendicular to trunk, knee flexion ≥90°, knee extension ≤180°, and hip extension ≤180° prior to ground contact with foot. By performing shallow water sprinting with this technique, individuals can adequately mimic the movement pattern of sprinting on land while in an aquatic environment.

Data Collection

All trials in both mediums were recorded from the right sagittal view. One representative stride was then taken from each participant in both water and on land. The means were then compared between land vs water in each variable.

Results

Stride Rate

Stride rate refers to the time between foot contacts of the same foot. A significant difference was reported for SL with a 2.67% difference between LSL and AqSL.

Stride Length

Stride length refers to the distance traveled between successive contacts of the same right foot. A significant difference was reported for SR with a 4.72 m/s faster on land.

Speed

Speed refers to the rate at which an object is moving and is calculated by multiplying the SR x the SL. We found that the subjects ran significantly faster on land than in the water. In fact, they ran 4.72 m/s faster on land.

Hip to Foot Ratio

The hip to foot ratio refers to where the foot contacts the surface relative to the hip. A significant difference was reported for the hip to foot ratio, with a 1.8m mean difference between land hip to foot ratio and aquatic hip to foot ratio. Interestingly, the foot consistently landed behind the hip in the water and for the majority slightly ahead of the hip on land.

Summary and Conclusion

The aquatic-based sprinting style was found to have significant lower extremity kinematic differences when compared to the land-based sprinting style. This applied to all of the kinematic variables that were measured with the exception of single leg support time and single leg swing time. This study illustrates the differences that may be exhibited while using shallow water sprinting for injury prevention, rehabilitation, as well as sport specific training. However, these differences are due to fluid mechanics, e.g. drag, buoyancy, and hydrostatic pressure. Although the benefits of shallow water running or not clearly understood, the data presented suggests the need for future research to further the knowledge and understanding of this form of exercise.

Selected References


More references are available upon request.

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