Kinematic Differences Between Land and Shallow-Water Sprinting

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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

Participants

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 joga bra, spandex, as well as athletic 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 III athletes whom participated in either soccer or track and field. The mean age among the participants was 19.20 years (±0.94), 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 22.3% (±5.4%).

Familiarization

Stereotypically people adopt a drive style, which looks similar to high knee 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 ≥30° 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 SPSS statistical 21 (repeated T tests) relative to stride rate (SR), stride length (SL), speed, hip to foot ratio, single leg support time (SLS), and single leg swing time (SW). An alpha level of p = 0.05 was used.

Results

Stride Rate

Stride rate refers to the time between foot contacts of the same foot. We found that there was a 0.93 Hz slower SR in water than on land, which was significant.

Stride Length

Stride length refers to the distance traveled between successive contacts of the same right foot. A significant difference was reported for SL with a 2.07 m difference between LSL and AqSL.

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.

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.

Acknowledgments

We would like to thank the following people for making this research project possible:

Dr. Sarah Costo, Participants, & Linfield College

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