Analysis of selected kinematic parameters which condition children locomotion in water

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1. Introduction

The mechanism of the human moving in water relies on the mutual impact of particular segments of the locomotion system. The essence of a small child locomotion in water is not developing speed, but primarily maintaining on the water surface and crossing the longest possible distance [1]. The subject of this work is the time and space analysis of the locomotion cycle of the infants’ lower limb during the locomotion in water.

2. Methods

Until recently, infants’ and infants’ locomotion in water has not been researched in the biomechanically due to specific properties of the sample population as well as the highly advanced and expensive measurement and research post [2]. Healthy children in the post-infant age participating in the early water locomotion stimulation programme were the subject for this research. The research method consisted in underwater registration of the movements of the lower limbs which are the main locomotion mechanism of infants. To monitor changes in the way of making the movement in water, the filming method and specialised software (SIMI computer motion analysis) were used. The system of markers was placed on the infant’s lower limbs and it allowed to register the changes of their positions in time. The following kinematic parameters of motion were established: path, motion velocity and range of movement in joints: the hip, the knee and foot joints. It was assumed that there is a relationship between the biomechanical parameter describing the motion such as the change of the angle value in the lower limb joints in time, and the value impacting the final result, i.e. the length of the path [3]. The research procedure consisted in mapping out the points, dividing the angles into cycles (pic.1.), time division of cycles, angle division of cycles, time normalization of the cycle, normalization of cycle angles, and determining average time of the cycles.

The result of the film research work were the biomechanical graphs which showed high changeability. The next procedures focused on normalisation, i.e. the conversion of the original time scale expressed in seconds into the percentage scale. Such an operation allowed for the comparison of the experiments and it enabled pinpointing where in the locomotion cycle the characteristic changes appear. The size of the kinematic parameters in the hip, knee and foot joints presented in time became the basis of the statistic calculations.

The statistical analysis was conducted and its purpose was to show the impact of the biomechanical parameter (the angle of the hip joint) to the length of the path covered (path) [5].

The extreme values were chosen for which the arithmetical average and standard deviations were worked out.
Table 1. The results of the statistical calculation for the angle value in the hip joint.

<table>
<thead>
<tr>
<th>Average</th>
<th>Standard deviation</th>
<th>Maximum</th>
<th>Maximum time</th>
<th>Minimum</th>
<th>Minimum time</th>
<th>Range</th>
<th>Number of samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>141.467270</td>
<td>21.028610</td>
<td>172.964536</td>
<td>0.601818</td>
<td>107.308945</td>
<td>1.034545</td>
<td>65.655591</td>
<td>71.181818</td>
</tr>
</tbody>
</table>

The mathematical analysis was conducted based on the calculus of variations and variable calculus.

3. Results

The conducted research procedures allowed to show to what degree the analysed values have a prognostic character and thus are determine whether they can be an evaluation criterion for assessing effectiveness of a small child’s locomotion in water. Parameters chosen for the profile of motion behaviour of infants in water confirmed the cyclical time space frame where fluidity and extensiveness of movement are among the most essential movement features. The research results confirmed the purposefulness of the adopted criteria which were the angle changes in the particular joint of the lower limb over time function. The criterion of the movement fluidity allowed to establish to what degree the child is kinesthetically adapted to performing tasks in water.

4. Discussion

From the hydrodynamical point of view, locomotion result of the human in water is the compilation of the translational motion which is the movement forward and the rotation motion which is the movement of lower and upper limbs [4]. In the case of the infant, the lower limbs are the main propelling mechanism during the locomotion in water. The biomechanical analysis of infants’ motion in water showed a relationship between changes of the angle value in joint of the lower limb and the time of their occurrence in the motion cycle.

References