Kinematical and dynamical characteristics of gait in step aerobics and overloads of movement system

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1. Introduction

Step is a common physical activity which can have positive or negative influence on human movement system. Every step aerobics session involves a large number of loading cycles and if volume and intensity of the training are too high they may cause overloads or injuries [1]. The loads in step aerobics depend on movement technique [2], stepping rate- music tempo [3], step height [4], damping properties of the step [5], type of steps [6]. Loads also depend on movement phase: they are different while ascending and for descending of the step [7]. One of most important factors that may differ loads in step is experience of participants [8]. The knowledge of magnitude of loads and its characteristics may help in selecting proper conditions to avoid overloads of movement system for both instructors and participants of the step aerobics class. Performing basic step is similar in movement structure to natural gait and stair climbing [4]. Because overloads depends on movement technique [2], the comparison of kinematic and kinetic parameters between people experienced in movement task and those with no experience can be used to asses biomechanical loads. The aim of this study was to compare kinematical and dynamical parameters in basic step in step aerobics between novice and experience groups.

2. Material and method

Total of 48 healthy females of the University School of Physical Education in Wrocław took part in the experiment. The material was divided into two groups: (NG) novice group and (EG) experience group. There was no statistical differences between body height and body mass parameters between both groups. The novice group did not have any experience in step aerobics. The subjects in experience group ware professionally qualified fitness instructors. All the subjects were selected to have the leading right leg. Subjects were barefoot to maintain similar measurement conditions. Each of the participants signed a written consent form. Research approval for the study was obtained from the local ethic’s committee of the University School of Physical Education in Wroclaw.

The moving task consisted of 11 “basic steps” performed on the bench at the height of 15 cm (average step height) and the music tempo was 132 bpm (bits per minute recommended on step aerobics class), which simulated natural environment in step aerobics. The basic step consists in stepping up the platform with right foot, adding the left one, stepping down with the right foot and bringing down the left again. The movement was repeated 11 times by each subject. Kinematics and dynamics of the movement task was assessed by a 3D motion analysis system BTS Smart-E (BTS Smart-E System, Milan, Italy) which consists of six infrared cameras (1.1 m, 120 fps), two video cameras NetworkCam AXIS 210A (20 fps), two Kistler 9286A forceplates (1kHz each). Twenty-two retroreflective passive markers were placed on subject’s body to denote main anthropometric landmarks according to Helen Hayes-Davis protocol [9].

![Fig. 1. Movement sequence. The ground reaction vector acting on feet supported on an upper/bottom platform is marked by a gray arrow. The subsequent stance phases of gait are: ASCEND: A) initial contact on a upper platform, B) max GRF upper platform, C) loading response (terminal contact on a bottom platform), D) single stance upper platform, DESCEND: E) initial contact on a bottom platform, F) max GRF bottom platform.](image-url)

The temporospatial parameters of the movement were measured and the angle-time characteristics of joints motion acquired. Ground reaction forces (GRF) were measured on a two force plates, first located in front of the step and second on a stable platform (Figure 1). The gait parameters were standardized to body mass or body height of the subjects. Data registration and computation was supported by the BTS software. Since 2001 the
3. Results

Main components of GRF vector and example angular kinematics for the ankle joint in sagittal plane and lateral plane and in knee joint in sagittal plane for the novice group and experience group are shown in Fig. 2.

![Fig. 2. Main components of GRF vector (on the left) and example angular kinematics for the ankle in sagittal and lateral plane and knee in sagittal plane for the novice group (dark curves) and experience group (light, background curves).](image)

4. Discussion

Likewise for other authors [1, 2, 3, 8] both experienced and novice group generate greater values of vertical ground reaction forces during descending (1,61 BW-experienced group, 1,62 BW-novice group) then ascending the step (1,01 BW-experienced group, 1,02 BW-novice group). Vertical GRF during descending can be reason of injuries for instructors and for participants of aerobics classes. During descending from the step greater values of lateral GRF were observed for novice group. Risk of injuries in inexperienced people is also supported by values of angle in transversal plane in ankle joint. Untrained individuals are placing foot more outwardly overloading its lateral part. No significant differences were observed in values of angle in knee joint during ascending, but during descending technique of placing lower limb on almost straight knee and during large values of vertical GRF can be the cause of injuries for both instructors and inexperienced people.

References