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High intensity repeated sprints impair postural control, but with no effects on free throwing accuracy, in under-19 basketball players

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1. Introduction

High intensity exercise is an intervenient aspect of postural control. After high intensity exercise, athletes present decreased postural control performance (Steinberg et al., 2016), which is evident in the form of increased body sway (Pau, Ibba, & Attene, 2013; Zemková & Hamar, 2014). Moreover, high intensity exercise leading to fatigue can cause an increase in the risk of injuries (Hebert, Corboy, Manago, & Schenkman, 2011; Steinberg et al., 2015). However, athletes who present better performances in repeated sprints (RSA), which is an all-out exercise, present less impairment in balance control, especially in the single-legged stance (Pau et al., 2013). In addition, improved general aerobic fitness attenuates the negative effects of fatigue on postural adjustments (Hebert et al., 2011) and better aerobic fitness improves body sway in non-fatigue conditions (Paillard, 2012; Steinberg et al., 2015). Specifically for basketball players, an adverse effect of high intensity exercise on passing accuracy in basketball has been shown, mainly in novice players when compared to experts (Lyons, Al-Nakeeb, & Nevill, 2006). In addition, an increment in exercise intensity seems to decrease performance (accuracy) in free throwing (Padulo, Attene et al., 2015), but without significant effects on the kinematics of free throw shooting (Uygur, Goktepe, Ak, Karabörk, & Korkusuz, 2010).

Postural control is considered one of the limiting factors of sport performance, involving multiple sensorimotor processes (Horak & Macpherson, 2011; Zemková & Hamar, 2014). Modulations in body sway are necessary when practicing sport skills to support high intensity exercises and improve postural control (Zemková & Hamar, 2014). Increased postural instability seems to reduce performance (Zemková, 2009), principally in movements that requires accuracy, such as rifle shooting and archery (Mononen, Konttinen, Viitasalo, & Era, 2007; Platzer, Raschner, & Patterson, 2009). Accuracy in free throw shooting in basketball, which is a considerably decisive element in a basketball game (Uygur et al., 2010), has been related to low horizontal oscillation and high body stability (Hudson, 1985). Professional basketball players with better performance in shooting present higher postural control (Perrin, Perrin, Courant, Bene, & Durupt, 1990). However, in previous studies postural control has been assessed during controlled situations, when the athletes did not perform a high intensity exercise before the shooting. Rapid readjustment of postural control after high intensity exercise is considered an important ability to improve basketball performance and avoid injuries (Steinberg et al., 2015, 2016; Zemková & Hamar, 2014). Therefore, the question of this study is: What are the effects of high intensity exercise on body sway (postural control) and accuracy in free throw shooting in basketball players?

The aim of this study was to investigate the effects of high intensity exercise (all-out sprints) on body sway in under-19 basketball players during bipedal stance and to correlate body sway parameters and free throwing performance, and body sway parameters and

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performance in high intensity exercise. We hypothesized that high intensity exercise performed through an RSA protocol would increase body sway and there would be a negative relation between body sway parameters and performance and a positive relation between body sway and performance in high intensity exercise (higher performance with smaller body sway). The study of the effects of all-out exercise on body sway in basketball players is important for performance purposes, since deficits in postural control may decrease performance and increase the risk of injuries (Pau et al., 2013; Zemková & Hamar, 2014).

2. METHODS

2.1. Subjects

Twenty-five male under-19 basketball players from a Brazilian team participated in the study (16- to 19-years old, height: 1.90 ± 0.09 m; body mass: 75.75 ± 3.86 kg, arm span: 1.97 ± 0.96 m). The athletes had at least three years basketball experience and participated in 12 h of training per week. The athletes were national level and the majority participated in training with the professional team. The inclusion criteria for the study were: i) having participated regularly in previous national competitive seasons and ii) being healthy (no chronic diseases and/or musculoskeletal injuries).

2.2. Design

Participants were required to abstain from alcohol or caffeinated beverages during the experimental period and eat at least 2–3 h prior to testing, to reduce any interference in the experiment. All tests were conducted on an indoor basketball court. The tests were performed in the same period of the day (from 16:00 to 20:00 h – regular training schedule) to eliminate any influence of the circadian cycle. The athletes were rested before the test. The study was approved by the local ethics committee. All participants and their parents/guardians signed an informed consent form.

2.3. Methodology

A force plate – 50 × 50 cm (AccuGait, Advanced Mechanical Technologies, Boston, MA, USA), with a rate of 100 samples/s, was used to analyse postural control. Body sway was measured before and after a high intensity exercise (RSA) protocol (Fig. 1). The evaluation of body sway after the RSA protocol was performed after free throws without a rest period. Each participant performed three trials of 30 s each in a quiet stance (due to the protocol design, short rest time between the sprints – 30 s, it was not possible to perform more time in a quiet stance for each trial). Participants were instructed to: i) position their feet parallel to each other (placed at a similar distance from the pelvis and the position was maintained in each trial); ii) stand quietly in an upright position; iii) keep their eyes open and direct their gaze to the front (an experienced researcher ensured that the participants remained quiet with their gaze to the front). The three force and moment components were acquired in the vertical, anterior-posterior, and medio-lateral directions. The mean center of pressure (CoP) signal was calculated for each analysis. The first 10 s of each recording was ignored systematically to avoid potential disturbances resulting from delayed stabilization after the participant stepped onto the force plate. The data were then filtered with a fourth order low-pass Butterworth filter with a cut-off frequency of 5 Hz determined by residual analysis (Winter, 2009).

The following parameters of the CoP in the anterior-posterior and medio-lateral directions were analysed: the total displacement of sway (i.e., the length of the CoP trajectory on the support base); the mean velocity of sway (i.e., the displacement of the total sway of the CoP divided by the total duration of the trial); the root mean square (RMS) of sway displacement (i.e., the CoP variability around the mean CoP trajectory); and spectral analysis of the position time series, separately in each direction, and used to calculate the median frequencies of the data (Matlab software version 7.10, Mathworks). In addition, the area of sway (i.e., the area of an ellipse containing 95% of the CoP data) was calculated.

2.3.1. Repeated sprint ability test

An RSA protocol was used to simulate high intensity exercise (all-out sprints) (Milioni, Redkva, Barbieri, & Zagatto, 2017; Padulo, Laffaye et al., 2015). The test consisted of ten 30 m sprints with two 180° changes of direction (10 m + 10 m + 10 m), interspaced by 30 s of passive recovery between the sprints (Padulo, Laffaye et al., 2015; Zagatto et al., 2017) and with an exercise-to-rest ratio of 1:5 (Ruscello et al., 2013) (test-retest Intraclass correlation > 0.90) (Padulo, Laffaye et al., 2015). Time of each sprint was recorded using photoelectric cells (Speed Test – Cefise® – Nova Odessa – SP – Brazil) positioned at the beginning and end of the track. Verbal encouragement was given during the sprints. Before and after the RSA protocol, the athletes performed a set of three free throws (4.6 m - free throw line distance from point on floor directly below backboard). Each set of three free throws was performed quickly (~10 s) during the recovery period. The accuracy (number of hits) was measured for each set.

The best time (BT – best sprint time), mean time (MT), worst time (WT – worst sprint time), and percentage decrement in sprint

Fig. 1. Schematic of the sequence of protocols in the experiment. RSA – repeated sprints.