Physical Therapy in Sport 16 (2015) 349–354

Contents lists available at ScienceDirect

Physical Therapy in Sport

journal homepage: www.elsevier.com/ptsp

Original research

Kung-fu versus swimming training and the effects on balance abilities in young adolescents

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ARTICLE INFO

Article history:
Received 19 August 2014
Received in revised form
7 January 2015
Accepted 27 January 2015

Keywords:
Kung-fu
Swimming
Balance control
Young adolescents

ABSTRACT

Objective: Our purpose is to investigate the static balance control of young adolescents practicing kung-fu and swimming in order to find out which of these physical activities is the most effective in developing specific balance abilities in young adolescents.
Design: Comparative experimental study.
Setting: University laboratory research.
Participants: Three groups of 11–13-year-old boys (12 practicing Kung-Fu, 12 practicing swimming and 12 controls).
Main outcome measures: Center of pressure (CoP) excursions were registered in upright bipedal and unipedal stances on a stabilometric force platform in eyes open (EO) and eyes closed (EC) conditions.
Results: Kung-fu practitioners control their balance ($P < .05$) better than controls and swimmers in the unipedal posture when visual inputs are available. Kung-fu training improved ($P < .05$) the bipedal balance control in the EO condition. However, swimming training developed ($P < .05$) bipedal balance control in both EO and EC conditions. The swimmers showed a lower reliance on vision ($P < .05$) compared to kung-fu practitioners.
Conclusions: Both of these physical activities could be recommended for young adolescents as recreational or rehabilitation programs as they develop specific balance abilities that could be important for improving and maintaining optimal health.

1. Introduction

Balance control is essential for the production of accurate movements and locomotion skills that are vital for activities of daily living like walking, stepping up the stairs, or standing on a bus (Sahli, Baccouch, & Rebai, 2014; Soberaa, Siedleckaa, & Syczewskab, 2011). It is derived from the integration of three major sensory inputs: visual, vestibular, and somatosensory systems (Cordo & Nashner, 1982). It has been reported that children show a greater magnitude of postural sway than adults during a quiet standing position (Peterson, Christou, & Rosengren, 2006) and their balance systems are not fully matured until the age of 14 (Fong, Fu, & Ng, 2012).

Many authors have been interested in the effect of athletic training on balance control in adults. The findings of their studies revealed that highly trained athletes demonstrated better postural control than sedentary subjects (Kioumourtzoglou, Derri, Mertzanidou, & Tzetzis, 1997; Perrin, Deviterne, Hugel, & Perrot, 2002; Robertson, Collins, Elliot, & Starkes, 1994) and acquired new balance control abilities probably vary according to the discipline practiced (Golomer, Cremieux, Dupui, Isableu, & Ohlmann, 1999; Paillard, Noe, Riviere, Marion, Montoya, & Dupui, 2006; Perrin et al., 2002). However, fewer studies have been conducted on how athletic training affects the balance control of children and young adolescents. It has been established that gymnastics training improves balance control of 5–7-year-old children. Indeed, young gymnasts rely on visual inputs in the eyes open (EO) condition to control their balance better than age matched non-gymnasts (Garcia, Barela J, Viana, & Barela A, 2011). Moreover, it has been found that 2 years of experience in circus activity training improves the balance control of 5–6-year old children in static and dynamic medial-lateral postures (Sahli

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http://dx.doi.org/10.1016/j.ptsp.2015.01.004
1466-853X/

et al., 2013). In the case of older children, 13-year-old soccer players improved their medial-lateral postural control and developed specific postural strategies characterized by decreased center of pressure (CoP) frequency and lower dependence on vision (Biec & Kuczyn'ski, 2010). Similarly, young adolescent taekwondo practitioners showed better balance control than controls (Fong et al., 2012). The improvements of balance control due to these activities have been only demonstrated by simple comparisons with sedentary participants. To the best of our knowledge, only one study compared balance control in young adolescent tennis players and young adolescent taekwondo practitioners (Fong, Chung, Ng, Ma, Chow, & Tsang, 2014). Even if young adolescent's balance systems are not fully matured until 14 years old as mentioned above (Fong et al., 2012), it is still not understood which of the many different types of sports are the most effective in developing specific balance control at this age.

Kung-fu competitors are trained to perform choreographic figures (i.e., Taolu) and fights (i.e., Sanda). The Taolu competitions are characterized by formal and standardized barehanded, long weapon and short weapon routines where movements are evaluated by precision, velocity, strength, body orientation and equilibrium. On the other hand, fighting competitions are characterized by full-contact punches, throw techniques and kicks in which unilateral stance stability is a determining factor of success (Artioli, Gualano, Franchini, Batista, Polacow, & Lancha, 2008). The literature on combat sports reported that athletes who grapple with opponents (i.e., judo athletes) or athletes who strike opponents (i.e., karate and taekwondo players) developed specific balance abilities (Cesaria & Bertucco, 2008; Fong et al., 2012, 2014; Perrin et al., 2002). Kung-fu training combines both grappling and striking techniques but there is little information regarding its effects on human balance control in adults or in younger people available in the scientific literature.

However, swimming is a different form of exercise compared with other traditional exercises that require weight bearing (Sharp, Troup, & Costill, 1982; Tanaka, Costill, Thomas, Fink, & Widrick, 1993). Swimming is an aquatic activity which takes place in a nearly zero-gravity situation with buoyancy of water (Tanaka & Seals, 1997). It has been established that swimming training improves eye-hand coordination and balance control in the elderly population (Hsu, Chou, Chen, Wong, Chen, & Hong, 2010). Nevertheless, it remains unclear how competitive swimming training affects the balance control of children and young adolescents.

Because swimming relies most on somatosensory inputs (Robert, Gueguen, Avogadro, & Mouchnino, 2004) in an aquatic field and kung-fu relies on both visual and somatosensory signals in a gravitational field (Artioli et al., 2008), it may be suggested that swimming and kung-fu might influence the balance control of young adolescents differently. Therefore, the aim of this study was to investigate the static balance performances of kung-fu and swimming young adolescent practitioners in order to find out which of these physical activities is the most effective in developing specific balance abilities in young adolescents.

2. Methods

2.1. Participants

Thirty six young adolescents participated in this study. They were divided into 3 groups: twelve swimming practitioners, twelve kung-fu practitioners with 5–6 years of training experience 4 times a week (1 h 30 min per session) for the two trained groups and 12 control children without previous experience in any type of sport but who were physically fit (Table 1). Kung-fu practitioners and swimming practitioners were recruited from a local kung-fu club and a municipal swimming pool. The sedentary participants were recruited from a state-funded school. Participants were included if they had the same criteria in terms of socio-economic status and ethnic origin. For the trained group, both of swimming and kung-fu practitioners were included if they have the same training experience period (between 5 and 6 years) and frequency (four times a week). Participants of the control group were matched for age, sex, weight, height and shoe size with those of the trained groups. The exclusion criteria were the presence of vestibular or visual disorders, musculoskeletal or neurological disease, history of injury in the previous 12 months requiring medical care and regular training in sports other than swimming or kung-fu. The study was approved by the Clinical Research Ethics Committee of the National Centre of Medicine and Sciences in Sport of Tunis. The procedures were fully explained to the participants as well as their parents who submitted written informed consent before testing.

2.2. Procedures

For the static postural condition, the CoP excursions were recorded using a static stabilometric platform (PostureWin©, Techno Concept®, Cereste, France; 40 Hz frequency, 12-bits A/D conversion) with three strain gauges. The stabilometric platform was level with the surrounding floor. For bipedal stance, the subjects were asked to stand as still as possible on the stabilometric platform with their arms comfortably placed downward at either side of the body, their bare feet separated by an angle of 30° and their heels placed 5 cm apart. To maintain the same foot positions for all the measurements, a plastic device provided with the platform was used. For unipedal stance, participants stood barefooted on their non-dominant leg with the dominant leg flexed to 45° at the hip and knee so as to resemble the starting position of a front kick. The subjects were first requested to maintain balance with the EO and then with the eyes closed (EC). In the EO condition, participants were instructed to look straight ahead at a white cross placed onto the wall 2 m away at eye level. In the EC conditions, they were asked to keep their gaze horizontal in a straight-ahead direction. Thus, in the present study, four experimental conditions were tested for each participant:

- Bipedal-EO
- Bipedal-EC

Table 1
Characteristics of participants.

	Controls (n = 12)	Kung-fu practitioners (n = 12)	Swimming practitioners (n = 12)	P Value
Mean Age ± SD (years)	12.33 ± 0.8	11.9 ± 1.0	12.48 ± 0.3	0.13 (NS)
Mean Height ± SD (cm)	148 ± 2.7	146 ± 3.2	147 ± 2.9	0.26 (NS)
Mean Weight ± SD (Kg)	38 ± 1.3	37 ± 2.5	38 ± 1.7	0.10 (NS)
Mean shoe size ± SD (cm)	37 ± 1.4	38 ± 2.0	38 ± 1.2	0.08 (NS)

Notes. NS = non significant.