



THE EFFECT OF A 6-WEEK INTERVENTION PROGRAM ON TEMPORAL PARAMETERS RELATED TO HANDSPRING ON FLOOR EXERCISES

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Abstract:

Handstand is an exercise that requires upper and lower limb strength to rotate gymnasts over the hands. The purpose of the study was to examine the effect of a 6-week training program on temporal parameters during handstand exercise. The study involved 20 non-competitive female gymnasts who were randomly divided into an experimental group (EG) and a control group (CG). The intervention program lasted 6 weeks, twice a week, for 15 minutes each time and included motor skills related to the individual phases of the specific exercise. Results showed that the EG was statistically significantly superior to the CG in the time of the push leg to the vertical position. Further, although no statistically significant difference was found, there was a trend to improve the time of the swing leg to the vertical and the hand's push-off. In conclusion, the proposed training program brings about significant improvement in the temporal parameters of motor skills related to the practice of handstand.

Keywords: artistic gymnastics, floor exercises, plyometric training, handspring

1. Introduction

Floor exercises are a complex sport as they harmoniously combine flexibility with dynamism, expressiveness with strength, courage with self-control, and musicality with the rhythm of execution (Jurat & Potop, 2018) and require high levels of flexibility,

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strength and harmony in which the natural characteristics of each gender are emphasized, such as flexibility and grace in female athletes and endurance and strength in male athletes (Kalinski et al., 2018).

Coordination of movements and assimilation of the technical aspects of the exercise (Kaufmann et al., 2022) with a specific "position" of the individual parts of the body (Desai et al., 2019) are crucial for their execution, while the assimilation of auxiliary exercises related to the individual phases of the exercise plays a major role in learning the exercises. The handspring is a basic exercise (Stork, 2006) with forward body rotation (Marković & Omrčen, 2009), in which practitioners should coordinate the individual body parts (Desai et al., 2019) with minimal loss of horizontal velocity (Živčić-Marković et al., 2012) where the hand push phase is an important phase (Živčić et al., 2007) that is influenced by the position of the CSF in relation to the support surface (Živčić-Marković et al., 2012).

A plyometric training program contains specialized exercises depending on the sport (Wang & Zhang, 2016). In artistic gymnastics (AG), plyometric exercises (PE) occupy a significant time in the training process of athletes (Marina et al., 2012) contributing to the increase in strength, speed, endurance (Mirela, 2014), power (Hall et al., 2016; Mirela, 2014) with a characteristic increase in lower limb strength in young ages (Branet et al., 2021; Lakshmikrishnan & Sivakumar, 2013; de Villarreal et al., 2010). However, there is no evidence that these PAs increase upper limb strength and power (Singla et al., 2018). Athletes can maximize force production (Fischetti et al., 2018; De Villarreal et al., 2010) and power (Booth & Orr, 2016) by using PA training, which focusses on the transition from muscle stretching to a rapid or explosive contraction, such as in specialized repetitive jumps, hops, etc. (Tottori & Fujita, 2019; Wang & Zhang, 2016). Jumping exercises are an effective way to activate the stretch-shortening cycle (Chaabene et al., 2021; Chelly et al., 2015). The aim of the study was to examine the effect of an intervention program on improving temporal parameters in handspring on floor exercises. It was hypothesized that there would be a statistically significant difference in performance after the 6-week intervention program in the velocity of the accelerated handstand and hand push-off.

2. Method

2.1 Participants

Twenty female non-competitive female AG athletes, aged 10.3 ± 1.45 years, weighing 38.63 ± 12.40 kg, standing 138.1 ± 8.17 cm and training experience of 25 ± 19.22 months, voluntarily participated in the present study. All participants were healthy and had no injuries in the last six months. Each subject came to the gym and, after presenting the written consent form of their guardians, who had been fully informed about the experimental procedure, had the right to withdraw at any time they wished.

2.2 Experimental procedure

Three days before the initial measurement, participants came to the gym with their guardians' consent form to record their somatometric data (height, weight, age). They were then randomly divided into an experimental (EG) and a control group (CG). Prior to the first and final measures, each group engaged in a ten-minute warm-up that comprised mild stretching, calm jogging, and upper- and lower-extremity muscular activation activities. The efforts were recorded using a tripod-mounted camera set to take 300 photos per second at a distance of 4.60 meters and perpendicular to the exercise execution axis. Participants performed a trial attempt before evaluating the variables under consideration: the arm push phase and the vertical acceleration.

- **Arm push phase:** Regarding the arm push phase, the participants had to perform an explosive movement of the upper limbs while supporting the hands on the ground in order to create a flight phase, until they were supported on the ground again. Each test subject performed two attempts in each measurement (initial and final). The best attempt was taken into account for the statistical processing.
- **Swinging to handstand:** In this phase, participants performed an accelerated vertical until the swinging leg reached the mat and the pushing leg followed. The EG, after the end of their standard training, performed the 6-week intervention training program, with a frequency of two sessions per week lasting 15 minutes each time. The intervention program contained exercises: (i) aimed at strengthening and improving their technical execution in specific positions related to the exercise of handstand, and (ii) included auxiliary exercises of handstand (Table 1)

Table 1: Intervention program

Exercises	1 st week		2 nd week		3 rd week		4 th week		5 th week		6 th week	
	1 st session	2 nd session	3 rd session	4 th session	5 th session	6 th session	7 th session	8 th session	9 th session	10 th session	11 th session	12 th session
1	2 x 5		2 x 5	2 x 10	2 x 5	2 x 5	2 x 10	1 x 10	2 x 8	2 x 10	2 x 5	2 x 5
2		2 x 5	2 x 8		2 x 10	2 x 10	2 x 15	1 x 12	2 x 10	2 x 15	2 x 8	2 x 10
3	2 x 10	2 x 5	2 x 10	4 x 10	2 x 15	3 x 12	2 x 15	3 x 20	3 x 15	2 x 15	3 x 15	2 x 15
4	2 x 5	2 x 5		2 x 8		3 x 8						
5		2 x 10	1 x 10		2 x 10		2 x 10	2 x 10	2 x 10	2 x 10	2 x 5	2 x 10
6	1 x 4	1 x 4	2 x 6		1 x 6	1 x 4	2 x 5	2 x 8	2 x 8	2 x 5	1 x 4	1 x 6
Total contact	44	54	72	76	86	94	110	118	117	110	85	86

- 1) Vertical swing with greater level hand support (20–40 cm),
- 2) One-leg leap when the pushing leg is supported at a greater elevation (20 cm),
- 3) Alternate hip extension from the prone position on the horse,
- 4) Accelerated handstand,
- 5) Soft rubber shoulder flexors,

- 6) Blocking upper limbs on handstand (or with assistance) from a higher to a lower level.

2.3 Statistical analysis

Statistical analysis was performed using SPSS version 24 (IBM, New York, NY, USA). The 2 x 2 ANOVA method was used for statistical analysis to examine the interaction between group and measurement on the dependent variables. In cases where an interaction between group and measurement was found, the simple effect was examined using the Bonferroni correction. In cases where there was no interaction, the main effect on the dependent variable was examined. The significance level was set at $p < .05$.

3. Results

No interaction effect was observed between groups (experimental and control) and time of swing of the leg to the vertical position ($F_{(1)} = .078, p = .784$). However, a statistically significant main effect was found on time ($F_{(1)} = 11.064, p = .004$). The results are presented in Figure 4.1. Descriptive statistics of the variables under examination are presented in Table 2.

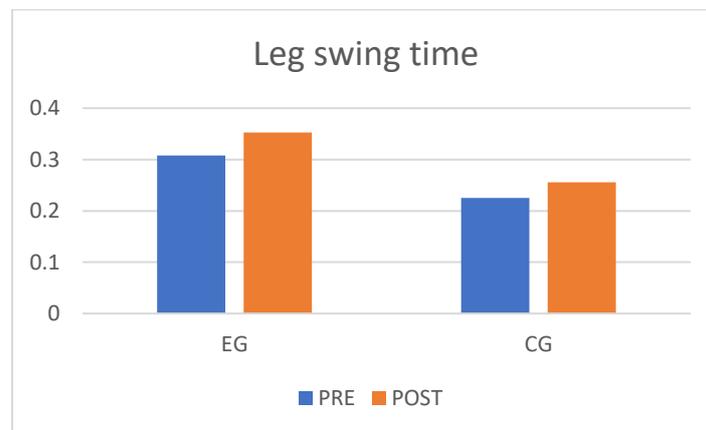


Figure 1: Average values of groups before and after the interventional protocol regarding the time of swing of the leg until the vertical

Table 2: Descriptive statistics (means and standard deviations) of the groups in the individual measurements of the variables under examination (standard deviation is indicated in parentheses)

	Leg swing time to vertical (sec)		Leg push time to vertical (sec)		Hand push time (sec)	
	Pre	Post	Pre	Post	Pre	Post
EG	0.308 (0.11)	0.225 (0.05)	0.584 (0.10)	0.382 (0.05)	0.169 (0.07)	0.148 (0.03)
CG	0.353 (0.14)	0.256 (0.10)	0.408 (0.16)	0.424 (0.10)	0.17 (.03)	0.162 (0.03)

Results showed a statistically significant interaction effect between groups and time of the push leg to the vertical ($F_{(1)} = 5.422, p = .038$). Also, a statistically significant main effect was found on time ($F_{(1)} = 16.824, p = .001$) (Figure 2).

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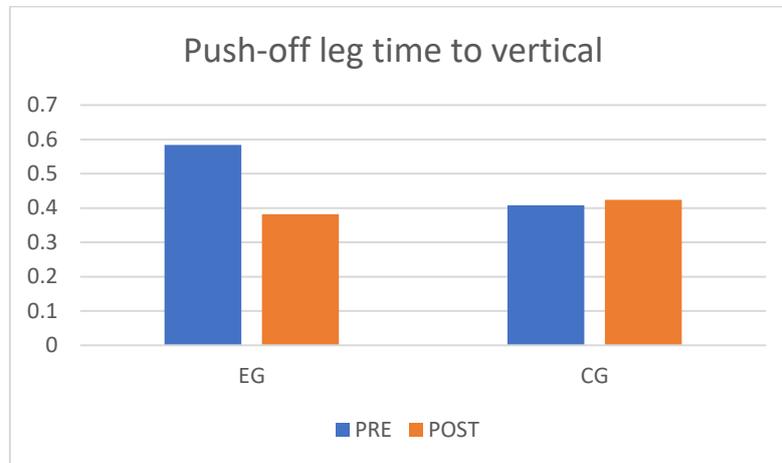


Figure 2: Average values of groups before and after the interventional protocol regarding the time of the push leg to the vertical

3.1 Hand push-off time

Results did not reveal a statistically significant interaction effect between groups and time of swing of the leg to the vertical ($F_{(1)} = 0.011$, $p = .921$). Also, no statistically significant difference was found in the time factor ($F_{(1)} = 0.728$, $p = .426$), nor in the group factor ($F_{(1)} = 0.253$, $p = .633$) (Figure 3).

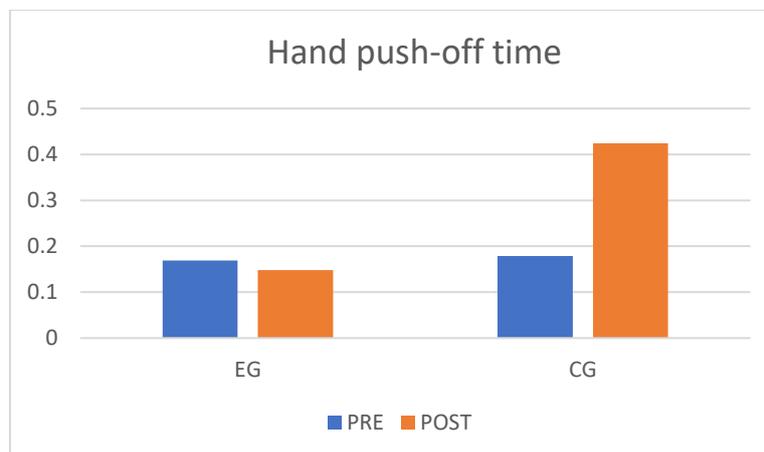


Figure 3: Average values of the groups (P.O. – O.E.) before and after the interventional protocol regarding the time of the push leg to the vertical

The percentage of group differentiation in the examined variables (leg swing time to vertical, leg push-off time and arm push-off time) are presented in Figure 4.

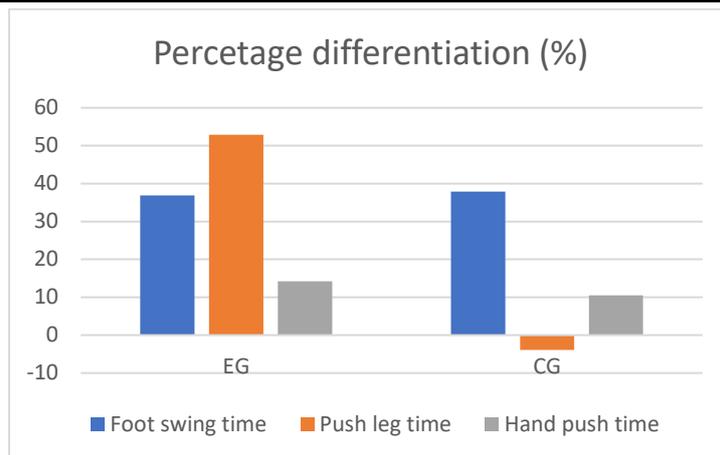


Figure 4: Percentage of differentiation of groups in the variables under consideration

4. Discussion

The results showed that the EG was statistically significantly superior to the CG in the time of pushing leg to the vertical position. Although no statistically significant difference was found, there was a trend of improvement in the time of the swing of the leg to the vertical and in the time of the push of the hands. In contrast to the EG, the CG showed a statistically significant reduction in the time required for the pushing leg to reach the vertical, while it showed a trend of improvement in the time of the swing of the leg to the vertical and in the push of the hands. These results, for the hand push, are consistent with the study by Sayah (2019), but differ in terms of the level of the subjects. The reduced time shown in our study in the CG can be explained by the technical errors made by the participants. The small improvement in EG performance in the hand push is consistent with the review by Singla et al. (2018), which reports that with plyometric training, there was a small increase in upper limb strength. Regarding vertical support, the results showed that plyometric training combined with strength training improves lower limb speed due to the subsequent improvement in the vertical swing time of the leg, a result that is consistent with the findings of previous studies (Slimani et al., 2016; Vassil & Bazanovk, 2012).

Based on the results of our research, it appeared that the EG improved during the time of pushing the leg to the vertical, while there was also a small improvement in the time of pushing the arms and the time of swinging the leg to the vertical. The CG also showed a small improvement in the time of pushing the arms and the time of swinging the leg to the vertical, while the time of pushing the leg to the vertical was also reduced. The results should be discussed taking into account the following limitations. The intervention program was implemented in female athletes aged 8-12 years in addition to the established club training, while the control group implemented only the club training program.

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Conflict of Interest Statement

The authors declare no conflicts of interest.

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