EFFECT OF EIGHT WEEKS VIBRATION TRAINING ON THE LOWER LIMB BASIC ABILITY AND ATHLETIC PERFORMANCE OF GYMNASTS

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The purpose of this study explores the effects of 8 weeks vibration training on the basic ability (explosive power, speed, agility) and athletic performance (backward somersault) of the lower limbs of gymnasts. Sixteen gymnasts were randomly divided into vibration training group (VT) and control group (CON). Participants were trained for eight weeks and performed countermovement jump (CMJ), sprints, shuttle run, and backward somersault tests before the training, after 4 weeks, and 8 weeks of training. The significant level was set to $\alpha = .05$. The results showed that the speed of VT increased significantly after 4 weeks of training, and the speed and agility of VT increased significantly after 8 weeks of training ($p < .05$). In conclusion, Gymnasts can improve their speed ability through 4 weeks of vibration training, and 8 weeks vibration training can improve their speed and agility.

KEYWORDS: backward somersault、countermovement jump、sprint、shuttle run、artistic gymnastics.

INTRODUCTION: Gymnasts in the development process of basic movements towards difficult movements, physical training plays a very important role. Without good explosive power, speed, agility and other basic physical abilities, it is impossible to achieve ideal and perfect overall performance in terms of continuity between movements, technical correctness, stability of movement and physical endurance (Weng, & Kao, 2014). In artistic gymnastics, both men and women use the lower limbs on the floor exercise and vault, and the remaining movements must use the lower limbs to finish the landing after implementing various movement techniques (International Gymnastics Federation, 2017). Therefore, in addition to movement physical training in addition to specialized technical training, additional physical training is required to more effectively strengthen the basic ability required by the lower limbs, thereby improving the athletic performance of the lower limbs. Vibration training is used to improve the basic ability of the lower limbs. A kind of physical training. In the early days, it was used in medical treatment, but it was subsequently improved by the Netherlands Olympic coach. It gradually developed vibration training into physical training and research. It is another way to use vibration stimulation to improve the athlete's neuromuscular system so that athletes can increase explosive strength, speed, and agility to promote athletes' better performance (Wyon, Guinan, & Hawkey, 2010; Colson, Pensini, Espinosa, Garrandes, & Legros, 2010; Di Giminiani, Masedu, Padulo, Tihanyi, & Valenti, 2015). Four factors affect the effect of vibration training; 1. The amplitude and frequency range are the training strengths that mainly determine the load on the human body (Cardinale & Lim, 2003; Mester, Kleinoder, & Yue, 2006). 2. Vibration stimulation time: divided into short-term vibration training effects (≦ 4 weeks) and long-term vibration training effects (> 4 weeks) (Griffin, Garland, Ivanova, & Gossen, 2001). 3. Vibration stimulation site: local or whole-body vibration, you can choose to stimulate the vibration generated by the machine to the tendon or local muscle you want to strengthen (Kinser, Ramsey, O'bryant, Ayres, Sands, & Stone, 2008). 4. Human body motion design: consider the muscle tension, joint stiffness, and initial muscle length. Stretching the muscles in advance or contracting them isometrically can be more sensitive to vibrational stimuli, which can induce the effect of promotion. (Cochrane & Stannard, 2005). In conclusion, the purpose of this study is to investigate the training benefits of short-term and long-term vibration training on the basic ability and sports performance of the lower limbs of artistic gymnasts.

METHODS: The participants of this study were 16 college artistic gymnasts (age 21.2 ± 1.38, height 168.13 ± 6.14, weight 59.78 ± 4.82). The participants were randomly matched and divided into a vibration training (VT) and a control group (CON), with 8 people in each group.

On the day of the experiment, the participants were asked to perform a 20-minute standardized warm-up and then rest for 5 minutes. Then, they were tested on the basic abilities of the lower limbs (countermovement jump, 30-meter sprint, shuttle run) and athletic performance (backward somersault). The participants were allowed to rest for 5 minutes before the next test. Three trials were collected and the best performance was analyzed. After the pre-test, the groups will be divided. The data from the two pre-tests were statistically analysed, and follow-up experiments were conducted only if they did not reach significance between the two groups. Both groups maintained gymnastic training four times a week during the experimental period, but the VT group would conduct additional vibration training three times a week. The participants stood on a vibration training machine (Pro5, Power Plate, USA) in a squat position, flexed their knees at about 90 degrees, performed for 60 seconds, and rested for 60 seconds. Ten sets of vibration training were performed for a total of 20 minutes. The vibration training machine was set to a high vibration frequency of 50 Hz and amplitude of 4mm as suggested by Manimmanakorn (Manimmanakorn et al. 2014). Finally, after 4 weeks of training and 8 weeks of training, the same testing process and data collection will be performed for data processing and statistical analysis. The 30-meter sprint and shuttle run tests were collected by the FITLIGHT Trainer™ (Fitlight Trainer system, FITLIGHT Corp, Aurora, Canada). The sprint tests record start-up periods of 0-10 meters and the period of 10-30 meters, the shuttle run test records the fastest time of two sprints back and forth at a distance of 10 meters. A force plate (Kistler Instrumente AG, Winterthur, Switzerland) was used to collect the countermovement jump (CMJ) and backward somersault data. The best record of three trials was analyzed. Both tests record the jumping vertical ground reaction force (VGRF) and air time at the time of take-off, and then use the formula = 1/2 * g * t ^ 2 converts the flying time into the jump or somersault height. The data were analyzed by SPSS 22.0 with mixed-design two-way ANOVA. The significant level was $\alpha = .05$.

Table 1 Analysis of basic ability and athletic performance results

test Items	Variables	group	pre	4wks	8wks
countermovement jump	VGRF (BW)	VT	2.42 ± 0.16	2.46 ± 0.15	2.50 ± 0.17
		Con	2.40 ± 0.19	2.42 ± 0.17	2.43 ± 0.18
	Height (CM)	VT	32.86 ± 7.13	33.58 ± 7.17	34.33 ± 7.36
		Con	32.09 ± 8.98	32.04 ± 9.39	31.54 ± 9.46
30m sprint	0-10m Start (S)	VT	2.12 ± 0.17	1.94 ± 0.15*	1.88 ± 0.15*
		Con	1.97 ± 0.12	1.99 ± 0.16	1.98 ± 0.16
	10-30m Acc (S)	VT	4.98 ± 0.50	4.55 ± 0.52*	4.59 ± 0.53*
		Con	4.71 ± 0.33	4.79 ± 0.47	4.62 ± 0.39
shuttle run	Fast time (S)	VT	11.75 ± 0.61	11.34 ± 0.73	10.96 ± 0.67*
		Con	11.56 ± 0.94	11.95 ± 1.02	11.91 ± 0.90
backward somersault	VGRF (BW)	VT	3.12 ± 0.40	3.18 ± 0.45	3.37 ± 0.69
		Con	3.21 ± 0.82	3.19 ± 0.83	3.21 ± 0.76
	Height (CM)	VT	41.67 ± 5.15	42.96 ± 4.39	43.43 ± 4.92
		Con	41.54 ± 7.53	40.82 ± 5.87	39.88 ± 5.52

*$p < .05$, Compare with pre-test

RESULTS: No significant difference was found on VGRF and jumping height on CMJ performance before, 4 weeks, and 8 weeks of training between vibration and control group. There was a trend increase in VGRF and jumping height on the VT group after 8 weeks of training. The sprint test had significant differences between the 0-10 start and the 10-30 acceleration phase. The simple effect test indicated that the VT group was significantly different after 4 weeks and 8 weeks of training. The control group did not have a significant difference. The analysis of the shuttle run showed a significant difference after 8 weeks of training. No difference was found in the control group. No difference was found on VGRF and height on backward somersault performance before, 4 weeks, and 8 weeks of training between vibration and control group. There was a trend increase in VGRF and height in the VT group after 8 weeks of training.

DISCUSSION: This study found that after 4 weeks of vibration training, gymnasts in the VT group performed significantly better than the pre-test in speed performance. After 8 weeks of training, the VT group showed significantly better speed and agility performance than the pre-test, indicating that vibration training can significantly improve the speed and agility performance of gymnasts. The results show that after training, the CMJ of gymnasts has not improved significantly, but there is a trend increase for CMJ jumping height. However, the sprint run performance of the vibration group is significantly better than the pre-test after four or eight weeks of training, but the shuttle run only improves after 8 weeks but not 4 weeks of training. The performance of the backward somersault of the gymnasts did not improve significantly after four or eight weeks of training, but there is a trend of improvement for the vibration group. Previous research confirmed that vibration training and stretching can effectively improve the flexibility of the lower limbs of the gymnast without losing explosive strength. (Dallas, Kirialanis, & Mellos, 2014; Kinser et al., 2008; Dallas & Kirialanis, 2013). Therefore, this is the first study to investigate the effects of short-term 4 weeks and long-term 8 weeks vibration training on the lower limb basic ability and athletic performance of artistic gymnasts. Previous studies found 6 weeks of vibration training that improve the speed (4.26sec → 3.97sec) on the lower limbs of gymnasts which is in agreement with our study. They also found the explosive strength (21.69cm → 23.81cm) improve but not in our study (Dallas, Savvathi, Dallas, & Maridaki, 2019). The possible reasons were their participants are young gymnasts and trained in gymnastics clubs and participants have competed in the university gymnastic game. Age may be the factor for vibration training that needs further study (Marín & Rhea, 2010).

CONCLUSION: Based on the above results and discussions, this study found that short-term vibration training for 4 weeks can effectively improve the speed ability of gymnasts' lower limbs, while long-term vibration training for 8 weeks can effectively improve speed and agility.

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ACKNOWLEDGEMENTS:
This study was supported by the Ministry of Science and Technology, Taiwan (108-2410-H-003-113).