INVESTIGATING LOWER LIMB STRENGTH AND STATIC BALANCE IN ELITE GYMNASTS AND WRESTLERS WITH NON- ATHLETES

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The purpose of this study was to compare centre of gravity deviance to difference surfaces for adolescent male elite gymnasts and wrestlers with non-athletes. Subjects were asked to maintain balance in four standing postures: standing with open eyes and close eyes, standing with right leg and left leg. Quadriceps muscle and posterior muscle leg strength was collected with a dynamometer. There was difference in static balance in standing one leg (left) in end tasks. There were no significant differences in static balance in other tasks. Posterior muscle leg strength in elite athletes was significantly greater than non- athlete. There was no significant difference in quadriceps muscle. Gymnasts can decrease anterior-posterior and medial-lateral deviance on one leg to use vision feedback and proprioception.

KEY WORDS: static balance, anterior-posterior and medial-lateral deviance.

INTRODUCTION: Performing complex motor skills, such as those performed by gymnasts or dancers, requires a great sense of balance. Consistent with this view, Asseman (2008) showed that experts in gymnastics are faster than novices when they are required to walk across a balance beam as quickly as possible, suggesting that gymnasts can control their balance better than inexperienced athletes. It still remains unclear, however, if gymnasts can demonstrate a better sense of balance than sedentary or other sportsmen in non-acrobatic tasks, like standing as immobile as possible. This issue can be debated in the context of the two leading theories proposed for the transfer of motor abilities (i.e. the capability for performance in one task as a result of practice or experience on some other task).

On one hand, based on the general motor ability hypothesis, any human skill (like a better sense of balance) should remain observable among various tests. This opinion is supported by several studies. Using several tasks, Kioumourtzoglou et al. (1997) showed that elite gymnasts have better dynamic and static balance than novices. In addition, during unilateral leg movements performed while standing, Asseman and et al., (2004) reported that the lateral sway of the centre of pressure was smaller in dancers than in untrained subjects. On the other hand, there have also been reports showing that the transfer of motor abilities is not such a simplistic mechanism. Vuillerma's hypothesis (2001) predicted that transfer among skills should be quite low because motor abilities are specific to a particular task. A recent study conducted on ballet dancers suggested that these athletes develop specific modalities of balance that are not transferable to posture control in daily life situations. More confounding, Bressel, (2007) found that individual performances in a ladder climbing test and in an unstable balancing board test were poorly correlated. This means that there might not be a general balancing ability, but that this aptitude is likely to vary depending on the nature of the task.

Bearing these two camps of research in mind, a question arises; is gymnasts' aptitude for maintaining balance in complex moves transferable to more simple tasks? And is there any relationship between the static balance and the strength in the lower limb muscles?

On the basis of these considerations, the aim of this study was to compare centre of gravity deviance to difference conditions (standing with open eyes, standing with closed eyes, standing on the right leg and standing on the left leg) and the relationship between lower limb strength and static balance in adolescent boy elite gymnasts and wrestlers with adolescent non-athletes.

METHODS: Subjects: Forty four male subjects (16 gymnasts,14.2 ±0.8 y,160.1±3.0cm, and 40.1±4.9 kg; 12 wrestlers, 16.7 ±0.7 y,157.7 ±3.6 cm, and 55.9 ±6.0 kg; and 16 non-athlete, 14.8 ±0.8 y, 164 ±3.7 cm, and 53.5 ±5.9 kg) volunteered to participate in this study. Subjects were excluded if they had a history of multiple ankle sprains (three or more significant sprains within the last year), an ankle sprain or injury within the last six months, a history of multiple knee injuries (three or more within the last year), a knee injury or surgery within the last year, a history of multiple hip injuries (three or more within the last year), a hip injury or surgery within the last six months, history of multiple concussions (three or more in their life time), a concussion within the last six months, any neurological or central nervous system deficits, or was currently taking any medication that could affect the nervous system.
Procedures: Subjects were asked to maintain an upright and quiet stance on a force platform with four conditions: standing with open eyes, standing with closed eyes, standing with right leg and standing with left leg for 30sec. outcome variables included center of gravity deviance (COG) and mean deviance of the center of pressure in anterior-posterior (AP) and medial-lateral (ML) directions analyzed in time and frequency domains. Subject performed all tasks with three repetitions. The mean of the repetitions was used for analysis.
A calibrated hand-held dynamometer, the Nicholas manual muscle tester (MMT) model 01160 (Lafayette Instrument Company, Lafayette, IN 47903, USA) was used to test isometric muscle strength of the quadriceps, and posterior muscle for each leg using standard technique. The MMT has a digital accuracy of ±0.5% of full scale and a force range from 0.0 to 199.9 kg. Before the actual test, the subjects were given a demonstration and one trial to familiarize themselves with the required action. During the test, the subject was instructed to raise the limb to a specific height and maximally resist the examiner's efforts to depress it with the standard method and to hold it for three seconds. Each muscle strength test was repeated three times with a brief rest of one minute in between and the highest value was recorded. Statistical Analyses:To test the significant of the difference in outcome variables between the subject types a one way ANOVAs were used.

RESULTS: The mean center of gravity deviance for the four balance tasks is presented in the Table1.Figure 1 shows that the anterior-posterior (A / P) and medial-lateral (M / L) deviance in task 4. In task 1, task 2 and task 3 we found no significant effect between the three groups (P>0.05). The same statistical analyses led to different results in task 4. Indeed, between the gymnasts and wrestlers and wrestlers with non athletes, there was the significant difference in centre of gravity deviance.

Table 1
Mean Centre of Gravity Deviance in Three Groups

Task	*Mean centre of gravity deviance (SI %)*		
	Gymnasts	Wrestlers	Non-athletes
Standing with open eyes	5.41	4.79	5.21
Standing with closed eyes	6.48	5.30	5.42
Standing on right leg	8.04	8.75	9.48
Standing on left leg	7.65	8.17	11.28

The wrestlers had better static balance than gymnasts and non athletes in standing with open eyes and standing with closed eyes. In task 3 and 4 (Standing with right leg and standing with left leg) results were different and respectively gymnasts, wrestlers and non-athletes had better static balance.
Standing on the left leg for all subjects increased their anterior-posterior (A / P) deviance but this effect was weaker in the gymnasts.
In the medial – lateral the mean of deviance in of all groups was less but there was larger deviance for the gymnasts.

Posterior muscle leg strength in elite athletes had significant difference with non- athlete
There was no significant difference in quadriceps muscle strength between any of the groups.

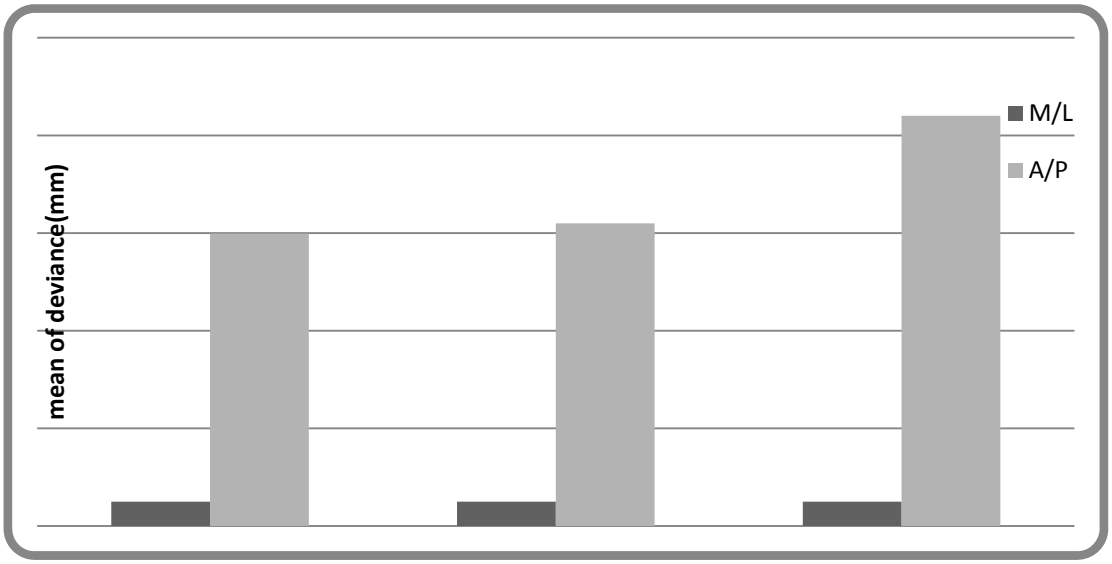

Figure 1: Anterior- posterior (A/P) and medial–lateral (M/L) deviance in standing on the left leg.

DISCUSSION: The first goal of this paper was to investigate if gymnasts have a more stable standing posture than other sport experts and non-athletes do. In all conditions, gymnasts were not more stable than other groups. Manipulating the difficulty of the task did not help to discriminate the performance of the three groups. Thus, the results do not support the general motor ability hypothesis, but rather argue in favor of Vuillerma's hypothesis under which the transfer of motor skills is not an automatic phenomenon. Based on our results, the eloquent sense of balance demonstrated by the gymnasts during their acrobatic moves does not provide any benefit to the achievement of more simple tasks, like balance control. As pointed out by Bachman's study, there might not be such general ability as balance, but rather the ability to maintain balance would depend on the task (Asseman, Caron, & Cremieux, 2008).
Comparing the three groups, it was found that rhythmic gymnasts had better strategies than other groups in medial – lateral deviance on the left leg. The most interesting finding in this study is that rhythmic gymnastics training seems to have a direct effect on the ability to maintain anterior- posterior which may use vision feedback and proprioceptor. These findings are similar to those reported by Calavalle et al. (2008), and Asseman et al. (2004).
In comparison there were no differences in quadriceps muscles strength between the gymnasts, wrestlers. There were significant differences between the muscles which were involved in plantar flexion. The strength of posterior leg muscles in gymnastics was minimum and wrestler had the maximum strength.

CONCLUSION: The results showed no direct evidence that sighted gymnasts would possess a better sense of balance than any other groups during static standing. We concluded that gymnasts are able to use the remaining sensory modalities to compensate for in unstable postures.

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