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Men and women do not have the same relation between body composition and postural sway during quiet standing

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SUMMARY

The aim of the present study was to evaluate the influence of body composition on the postural sway during quiet standing. Our hypothesis is that men and women do not have the same relation between body composition and postural sway during quiet standing. Participated in the study 50 men and 50 women; age range: 20-40 years old. The main outcome measures were: *Body composition* (bone densitometry), percentage of fat (% fat) tissue (g), fat (g), lean mass (g), bone mineral content (g) and bone mineral density (g/cm^2); *Anthropometry:* body mass (kg), height (cm), length of the trunk-head (cm), length of lower limbs (cm). The following indices were calculated: body mass index (BMI) (kg/m^2) and *Postural balance test* – center of pressure displacement. The correlation analysis showed low correlations between postural sway and anthropometric variables. The multiple linear regression model showed that the body composition and the anthropometry were able to explain only men's postural sway. The postural sway is sex type dependent. Men and women have different relations between body composition and postural sway. Only male's body composition affected the body sway.

INTRODUCTION

The upright posture as an inverted pendulum is a very simplistic way to understand the balance control. Which advances could be added to such a model? The spring controlled inverted pendulum [1] and the joint stiffness regulations are examples of how the inverted pendulum model was improved. The distribution of body mass affects the moment of inertia and consequently the movement of the pendulum. However, the difference in mass distribution in the body is not considered in none of the inverted pendulum models. Could the body composition (distribution of different biological tissues in the body) affect the body sway like the body mass or the body mass index? Individuals with normal or high body mass index (BMI) standing quiet on stable surfaces show similar postural sway[2], but a person with extreme BMI shows larger balance sway[3].

The aim of the present study was to evaluate the influence of body composition on the postural sway during quiet standing. Our hypothesis is that men and women do not have the same relation between body composition and postural sway during quiet standing.

METHODS

The participants were fifty not-sedentary men and fifty not-sedentary women aged between 20-40 years old. The anthropometric measurements are: body mass, body height, trunk-encephalic length, lower limb length and basis of support. The body mass index (BMI) was calculated. The dual energy X-ray absorptiometry (LUNAR-DPX, Madison, Corporation, USA) was applied for the body composition (fat mass, lean mass, soft tissue mass, bone mineral composition and bone mineral density).A force platform (AccuSway Plus, AMTI®, MA, USA) was applied to measure the ground reaction forces and moments of force during the quiet standing posture task.

RESULTS AND DISCUSSION

The results of the multivariable linear regression analysis among the anthropometric and body composition variables and postural sway are described in Table 1. For men, the body height and support base area explained 28% of the accounted variability of ML COP, the lean mass explained 10% of the accounted variability of AP COP, and BOS and lean mass explained 25% of the accounted variability of COP area. For women, no relation was found.

Only male's body composition affected the body sway. The difference between sexes in body composition can slightly change the behavior of the inverted pendulum model. Only for men, the lean mass correlates to the postural sway.

The weight transfer strategy depends on different variables according to sex. For men, it is also important the size of the basis of support and their lean mass; while, for women, only the lengths (whole body and lower limbs) are important.

Indeed, the lower basis of supports leads to higher postural sway in ML direction [4], and to control the increase in body sway, it is necessary to increase the lean mass, probably and mainly, the muscle mass to be able to generate more muscle force.

The greater the lean mass, the smaller was the postural sway. Although this statement can only be addressed to the male participants, the lost of muscular force is a risk factor for accidental falls. Two important facts in our results: in one hand, the increase in lean mass correlates to the decrease of the amplitude of the postural sway, on the hand, such an increase in lean mass also decreases the COP area. For the participants with large lean mass, those facts suggest that their postural sway is also safer than who have less lean mass. The safety in postural sway does not relate to its size, but also depends about how far is the COP to the border of the BOS.

The increase in body height affects the body mass and soft-tissue mass (lean and fat masses) increases the postural sway. The increase in body mass indeed enlarges the postural sway[2]; but, now we can say that such an effect depends on the person's sex.

The percentage of fat mass explains part of the AP postural sway in men, but not in women. For young women, the absence of relation between fat mass and postural sway suggests that fat mass effects on the postural control is aging dependent. Winters and Snow [5] reported that 31% of postural sway variability in premenopausal women was caused by the fat mass.

The increase in body height indeed increases the postural sway[2,6]. The linear regression analysis showed that height explained about of one fourth of the variations in postural sway. Berger et al.[6]stated that ankle displacements and the response of the gastrocnemius increased with increasing height The greater height in the male group may have been the reason for the greater influence of this parameter on COP in comparison to the females participants.

CONCLUSIONS

The postural sway is sex type dependent.
The importance of body composition in postural sway depends also on the sex type. Men's postural sway correlates to the lean mass and soft tissue mass.

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Table 1. The linear coefficient and the level of significance data related to the multivariate linear regression model analysis on the relation of postural sway (ML COP, AP COP and COP area) and the anthropometric and body composition variables for men and women.

		Beta value of the linear regression analysis *(level of significance p)*					**r^2**
	Variables	**Height**	**Trunk-cephalic length**	**basis of support**	**Lean mass**	**Lower-limb length**	
Women	**ML COP**	-	-	-	-	-	-
	AP COP	-	-	-	-	-	-
	COP area	-	-	-	-	-	-
Men	**ML COP**	0.01(<0.001)	-	-0.001 (<0.001)	-	-	0.28
	AP COP	-	-	-	60.7(0.01)	-	0.10
	COP area	-	-	-0.001(0.01)	10.7(<0.001)	-	0.25