ANTHROPOMETRIC FACTORS AND BODY COMPOSITION AND THEIR RELATIONSHIP WITH DYNAMIC BALANCE TESTS

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FATORES ANTROPOMÉTRICOS E COMPOSIÇÃO CORPORAL E SUAS RELAÇÕES COM TESTES DINÂMICOS DE EQUILÍBRIO

FACTORES ANTROPOMÉTRICOS Y COMPOSICIÓN CORPORAL Y SUS RELACIONES CON TESTS DINÁMICOS DE EQUILIBRIO

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ABSTRACT

Introduction: The limit of stability is characterized by the maximum angle of inclination that an individual can reach and greater variability in extreme conditions; it is a bold and/or dangerous motor control strategy. Objective: Assess whether anthropometric measurements and body composition interfere with limits of stability and weight-bearing at different speeds in adults. Methods: Eighty-seven subjects of both sexes aged between 20 and 40 years were analyzed using anthropometric assessment and body composition. A force platform, limits of stability (LoS) and rhythmic weight shift (RWS) tests were used for the balance assessments. Results: In the LoS test, being female was negatively correlated with foot size and reaction time, and positively correlated with maximum excursion. In the RWS test, the female group had a negative correlation with height and upper limb length (ULL), with mediolateral directional control. The male group had a negative correlation with ULL and laterolateral directional control. Conclusion: Body composition variables do not interfere in the LoS and RWS tests in subjects with normal body mass index (BMI) values, except for bone densitometry (BMD) in women. As regards anthropometric parameters, height, ULL and foot size in the female and male groups were as follows: ULL and foot size exert little influence on postural balance control. ***Level of evidence II, Diagnostic studies - Investigation of a diagnostic test.***

Keywords: Postural balance; Anthropometry; Body composition; Young adult.

RESUMO

Introdução: O limite de estabilidade caracteriza-se pelo ângulo máximo de inclinação que um indivíduo pode alcançar e pela maior variabilidade em condições extremas; trata-se de uma estratégia arrojada e/ou perigosa do controle motor. Objetivos: Avaliar se as medidas antropométricas e a composição corporal interferem nos limites de estabilidade e nas descargas de peso em diferentes velocidades em adultos. Métodos: Foram analisados 87 indivíduos de ambos os sexos, entre 20 a 40 anos de idade, por meio de avaliação antropométrica e composição corporal. Para as avaliações de equilíbrio foram usados uma plataforma de força, testes de limite de estabilidade (LE) e troca rítmica de peso (TRP). Resultados: No teste de LE, o sexo feminino correlacionou-se negativamente com o tamanho do pé e o tempo de reação e positivamente com a excursão máxima. Na TRP, o grupo feminino apresentou correlação negativa com estatura e comprimento do membro superior (CMS) com controle de direção médio-lateral. O grupo masculino apresentou correlação negativa com CMS e controle de direção látero-lateral. Conclusões: As variáveis de composição corporal não interferem nos testes de LE e TRP em indivíduos que apresentam valores de índice de massa corporal (IMC) dentro da normalidade, exceto a densitometria óssea (DMO) em mulheres. Quanto aos parâmetros antropométricos, estatura, CMS e tamanho dos pés no grupo feminino e no masculino foram os seguintes: CMS e tamanho dos pés têm pouca influência no controle do equilíbrio postural. ***Nível de evidência II, Estudos diagnósticos – Investigação de um exame para diagnóstico***.

Descritores: *Equilíbrio postural; Antropometria; Composição corporal; Adulto jovem.*

RESUMEN

Introducción: El límite de estabilidad se caracteriza por el ángulo de inclinación máximo que puede alcanzar un individuo y por la mayor variabilidad en condiciones extremas; se trata de una estrategia audaz y/o peligrosa de control motor. Objetivos: Evaluar si las medidas antropométricas y la composición corporal interfieren en los límites de estabilidad y en las descargas de peso en diferentes velocidades en adultos. Métodos: Fueron analizados 87 individuos de ambos sexos, entre 20 a 40 años de edad, por medio de evaluación antropométrica y composición corporal. Para las evaluaciones de equilibrio se usaron una plataforma de fuerza, tests de límite de estabilidad (LE) e intercambio rítmico de peso (IRP). Resultados: En el test de LE, el sexo femenino se correlacionó negativamente con el tamaño del pie y el tiempo de reacción y positivamente con la excursión máxima. En el IRP el grupo femenino presentó correlación negativa con estatura y longitud de miembros superiores (LMS) con control de dirección medio-lateral.

El grupo masculino presentó correlación negativa con LMS y control de dirección latero-lateral. Conclusiones: Las variables de composición corporal no interfieren en los tests LE y IRP en individuos que presentan valores de índice de masa corporal (IMC) dentro de la normalidad, excepto la densitometría ósea (DMO) en mujeres. Sobre los parámetros antropométricos, estatura, LMS y tamaño de los pies en el grupo femenino y en el masculino fueron los siguientes: LMS y tamaño de los pies tienen poca influencia en el control del equilibrio postural. ***Nivel de evidencia II, Estudios diagnósticos - Investigación de un examen para diagnóstico.***

Descriptores: *Equilibrio postural; Antropometría; Composición corporal; Adulto joven.*

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INTRODUCTION

The limit of stability is characterized by the maximum angle of inclination that an individual can reach and greater variability in extreme conditions; it is a bold and/or dangerous motor control strategy.[1] According to Serra et al.,[2] greater amplitudes without falling may favor activities of daily living such as reaching or taking hold of objects.

Under semi-static conditions, anthropometric variables interfere only slightly in postural balance;[3,4] however, under more challenging conditions such as limits of stability and weight transfer, no consensus about response has yet been reached.[2,5,6]

In addition, could body composition, such as lean and fat mass, influence these limits of stability? and must these variables be taking into consideration during postural balance assessments?

In clinical practice, these responses are important, as the lack of consensus hinders the use of these tests as a safe tool to assess the risk of falling and the outcomes of therapeutic interventions.[4,7,8]

The objective of this study is to assess whether anthropometric measurements and body composition interfere with limits of stability and weight-bearing at different speeds in adults.

MATERIALS AND METHODS

This is a descriptive cross-sectional study carried out at the Motion Analysis Laboratory (MAL) of the Institute of Orthopedics and Traumatology (IOT) of Hospital das Clínicas (HC) of the School of Medicine of Universidade de São Paulo (FMUSP), in partnership with Universidade São Judas Tadeu, SP. The study was approved by the Ethics Committee for Analysis of Research Projects (CAPPesq) of the Clinical Directorate of HC-FMUSP (no. 1256/06). The bone density scan was carried out at the Radiology Department of IOT-HC - FMUSP.

Casuistry

A total of 87 subjects participated in the study: 41 female subjects with an average age of 26.5 (±5.3) years, and 46 male subjects with an average age of 27.9 (±6.2) years, with the following inclusion criteria: age between 20 and 40 years; no history of lower limb injury in the last six months; no regular physical activity in the last six months; absence of disease or functional impairment of the auditory, vestibular, proprioceptive, neurological and mental systems (self-reported); not having undergone any surgery on the lower/upper limbs and trunk; joint range of motion preserved in the lower/upper limbs and trunk; not taking drugs that alter postural balance; no lower limb dysmetria greater than one centimeter and physiological patterns of spinal curvature, signing of informed consent form (ICF). The exclusion criteria were: inability to perform any of the proposed tests.

The first stage consisted of the completion of an Identification Form containing personal data, collection of any symptoms displayed by the subject, regular drug product use; history of falls and history of physical activity. We then collected physical data: anthropometric assessment, body composition and postural balance on a single day.

Anthropometric measurements

Body Mass (Kg): a Welmy mechanical scale with a 150 kg ruler and 100 gram precision was used. The subject was instructed to wear only light clothing (shorts and T-shirt) and to be barefoot, facing the assessor and with their back to the scale display.

Height (cm): the measurement was taken with the use of a Wiso 2.10 m fixed stadiometer, considering the distance between the stadiometer platform and the crown of the head, based on the Frankfurt plane. The subject was trained to breathe in then hold their breath for the measurement to be taken.

Body Mass Index (BMI): BMI was calculated using the BMI = weight/height equation.[2]

Trunk-cephalic length (TCL) (cm): the subject was seated on a bench measuring 50 cm in height, which had been placed on the stadiometer platform, leaning against the tape measure scale. The measurement was taken following the same procedure as that adopted for height, i.e., based on the Frankfurt plane. The height of the bench was subtracted before noting down the measurement on the chart.

Lower limb length (LLL) (cm): a tape measure (1 meter) was used to analyze the difference between the height and the trunk-cephalic length measurements.

Foot length and width (cm): a tape measure and caliper were used to measure the distance between the end of the heel and the end of the hallux, providing the foot length measurement. Foot width was measured in the metatarsal region and at the heel. Both limbs were assessed, but only right-sided measurements were used for statistical analysis.

Body composition was assessed by bone densitometry scan, performed with dual energy X-ray absorptiometry (DXA) at LUNAR-DPX (Madison, Corporation, USA) by trained radiology technicians. The report was issued by a specialist physician. Body fat percentage (fat %); tissue (g); fat (g); lean mass (g), bone mineral content (BMC) (g) and bone mineral density (BMD) (g/cm^2) were assessed.

The postural balance analysis was performed using a platform associated with the Balance Master System (BMS) produced by Neurocom International INC®, Clackamas, OR, USA), which consists of equipment accompanied by software in version 7.0, composed of two force platforms joined by a pin, equipped with four sensors at the ends. These sensors detect the center of force of a subject by means of the mean horizontal and vertical pressures exerted by the subject's feet. The platforms are connected to a computer with a monitor, located in front of them and at the subject's eye level. The computer receives dual measurements of the force exerted on the plate, then analyzes the information and generates a resulting display or printed report.[8,9]

Limits of stability (LOS) test

From the standing position on the platform, the subject was instructed to position their feet at the distance determined at the top of the computer screen. Once the position was enabled, the system proceeded sequentially through the performance of voluntary movements, where the subject's center of gravity was represented by a symbolic visual cursor showing the position of the patient's body on the platform. To trigger cursor movement, the subject was asked to tilt their body towards the targets that appeared randomly on the computer screen in the anterior, right anterior, right lateral, right posterior, posterior, left posterior, left lateral and left anterior directions. The assessed parameters were: reaction time, oscillation speed, directional control, endpoint excursion and maximum excursion.[8,10]

The Rhythmic Weight Shift (RWS) Test is a protocol that quantifies the subject's ability to voluntarily move their center of gravity (CG) in the mediolateral and anteroposterior direction in a rhythmic manner at three speeds. On the computer screen, the subject's CG is presented by means of a symbolic visual cursor showing their position on the platform. With the intention of triggering cursor movement, the subject is asked to perform anteroposterior and mediolateral weight transfers.[10]

Statistical analysis

The collected data were stored and analyzed using the SPSS 20.0 program. The descriptive analysis of the sample was studied through mean and standard deviation. The Kolmogorov-Smirnov test was used to verify whether the continuous variables had a normal distribution. Spearman's correlation coefficient was used to relate the dependent variables (platform parameters) with the independent variables (anthropometric measurement and age, in the total population and separated by sex).

RESULTS

The anthropometric characteristics and body composition of the adults divided by sex are described in Table 1.

Limits of stability test

In the female group, foot size showed a negative correlation with reaction time (r = -, 334, p = 0.03) and a positive correlation with maximum excursion (r = 3003, p = 0.05); BMD had a negative correlation with movement speed (r = -.338 (0.03); and ULL (r = -.307 (0.05) and LLL (-.415 (p <0.001) were negatively correlated with directional control. In the male group there was no relationship between the limits of stability variables and the anthropometric factors/body composition (Table 2).

Rhythmic weight shift test

The female group showed a negative correlation with height (r = -0.354 p = 0.02) and ULL with control of mediolateral direction

Table 1. Anthropometric characteristics and body composition of adults divided by sex.

	Female group M(sd) N= 41	Male group M(sd) N= 46
Anthropometric characteristics		
Body mass (kg)	60.9 (10.1)	78.2 (11.4)
Height (cm)	161.6 (6.4)	175.8 (6.4)
BMI (kg/m²)	23.2 (3.5)	25.2 (3.1)
ULL (cm)	160.0 (8.5)	177.2 (8.6)
TCL (cm)	87.4 (3.3)	92.1 (4.3)
LLL (cm)	74.0 (4.5)	83.8 (5.4)
Foot size	22.9 (1.2)	25.4 (1.3)
Body composition		
Fat %	44.4 (46.5)	22.7 (7.8)
Tissue (g)	58744 (9917.9)	75050.4 (11229.2)
Fat (g)	22233.0 (7062.9)	17719.3 (7836.5)
Lean (g)	36511.6 (4845.8)	57331.0 (6107.0)
BMD (g/cm²)	1144.7 (65.1)	1254.5 (80.7)
WHR (cm)	0.7 (0.0)	0.8 (0.0)

Spearman's r *p ≤0.05. BMI: Body Mass Index; ULL: Upper Limb Length; LLL: Lower Limb Length; TCL: Trunk-cephalic Length; BMD: Bone Mineral Density; WHR: Waist-to-Hip Ratio.

Table 2. Correlation between the Limits of Stability (LOS) Test and anthropometric variables and body composition of female volunteers (N=41).

	Reaction time	Speed of movement	Maximum excursion	Directional control
Female group				
Anthropometric characteristics				
Height (cm)	- 0.243 (0.12)	0.053 (0.74)	- 0.057 (0.72)	- 0.104 (0.51)
ULL (cm)	- 0.159 (0.32)	0.217 (0.17)	0.021 (0.89)	- 0.307 (0.05)*
TCL (cm)	- 0.079 (0.62)	0.117 (0.46)	0.197 (0.21)	0.148 (0.35)
LLL (cm)	- 0.202 (0.20)	0.023 (0.88)	- 0.235 (0.13)	- 0.415 (0.00)*
WHR (cm)	0.117 (0.46)	-0.101 (0.52)	0.244 (0.12)	0.054 (0.73)
Foot size	- 0.334 (0.03)*	0.234 (0.14)	0.303 (0.05)*	0.065 (0.68)
Body Composition				
Body mass (kg)	0.010 (0.95)	-0.040 (0.80)	0.047 (0.77)	0.081 (0.61)
BMI (kg/m²)	0.093 (0.56)	-0.067 (0.67)	0.081 (0.61)	0.177 (0.26)
Fat %	0.196 (0.21)	- 0.261 (0.09)	-0.230 (0.14)	-0.022 (0.88)
Tissue (g)	0.009 (0.95)	-0.023 (0.88)	0.045 (0.78)	0.060 (0.71)
Fat (g)	0.079 (0.62)	-0.111 (0.49)	- 0.032 (0.84)	0.104 (0.51)
Lean (g)	-0.068 (0.67)	0.120 (0.45)	0.156 (0.33)	0.041 (0.80)
BMD (g/cm²)	- 0.060 (0.71)	- 0.338 (0.03)*	-0.147 (0.36)	0.031 (0.84)
Male group				
Anthropometric characteristics				
Height (cm)	0.029 (0.84)	0.005 (0.97)	0.102 (0.50)	- 0.278 (0.06)
ULL (cm)	0.041 (0.78)	- 0.007 (0.96)	- 0.090 (0.55)	- 0.232 (0.12)
TCL (cm)	0.222 (0.13)	- 0.071 (0.64)	0.195 (0.19)	- 0.150 (0.31)
LLL (cm)	- 0.129 (0.39)	- 0.026 (0.86)	- 0.081 (0.59)	- 0.265 (0.07)
WHR (cm)	0.079 (0.60)	- 0.058 (0.70)	-0 .087 (0.56)	- 0.201 (0.18)
Foot size (cm)	0.257 (0.08)	- 0.202 (0.17)	- 0.046 (0.76)	- 0.095 (0.53)
Body Composition				
Body mass (kg)	0.182 (0.22)	- 0.069 (0.64)	0.085 (0.57)	-0.065 (0.66)
BMI (kg/m²)	0.161 (0.28)	- 0.081 (0.59)	0.044 (0.77)	0.045 (0.76)
Fat %	0.212 (0.15)	- 0.214 (0.15)	0.061 (0.68)	0.139 (0.35)
Tissue (g)	0.186 (0.21)	- 0.079 (0.60)	0.082 (0.58)	- 0.058 (0.70)
Fat (g)	0.209 (0.16)	- 0.181 (0.22)	0.063 (0.67)	0.089 (0.55)
Lean (g)	0.074 (0.62)	0.073 (0.63)	.032 (0.83)	- 0.223 (0.13)
BMD (g/cm²)	- 0.033 (0.83)	0.188 (0.23)	0.132 (0.40)	0.141 (0.37)

Spearman's r * p ≤0.05. BMI: Body Mass Index; ULL: Upper Limb Length; LLL: Lower Limb Length; TCL: Trunk-cephalic Length; BMD: Bone Mineral Density; WHR: Waist-to-Hip Ratio.

(-0.302 p = 0.05); BMD showed a negative correlation with control of mediolateral speed (r = -0.313 p=0.04), while WHR (waist-to-hip ratio) also showed a negative correlation with control of anteroposterior direction (r = -0.321, p = 0.04). The male group showed a negative correlation: between ULL and control of mediolateral direction (r = 358, p = 0.01); foot width (r = -0.297, p = 0.04); and LLL with control of anteroposterior direction (r = -0.297, p = 0.04) (Table 3).

Table 3. Correlation between the Rhythmic Weight Shift Test and anthropometric variables and body composition of female volunteers (N=41).

	Control of mediolateral speed r(p)	Control of mediolateral direction r(p)	Control of anteroposterior speed r(p)	Control of anteroposterior direction r(p)
Female group				
Anthropometric characteristics				
Height (cm)	0.003 (0.98)	- 0.354 (0.02)*	0.250 (0.11)	- 0.008 (0.96)
ULL (cm)	- 0.085 (0.59)	- 0.302 (0.05)*	0.257 (0.10)	- 0.022 (0.89)
TCL (cm)	0.004 (0.97)	- 0.181 (0.25)	0.156 (0.33)	0.100 (0.53)
LLL (cm)	- 0.219 (0.17)	- 0.293 (0.06)	- 0.007 (0.96)	- 0.207 (0.19)
WHR (cm)	- 0.246 (0.12)	- 0.050 (0.75)	- 0.077 (0.63)	- 0.321 (0.04)*
Foot size (cm)	.052 (0.74)	-.246 (0.12)	.288 (0.06)	0.056 (0.72)
Foot width (cm)	0.051 (0.75)	- 0.026 (0.87)	0.182 (0.25)	0.056 (0.72)
Body Composition				
Body mass (kg)	- 0.119 (0.45)	- 0.120 (0.45)	0.077 (0.63)	- 0.021 (0.89)
BMI (kg/m²)	- 0.037 (0.81)	- 0.015 (0.92)	0.068 (0.67)	0.056 (0.72)
Fat %	- 0.024 (0.88)	0.012 (0.93)	0.032 (0.844)	0.055 (0.73)
Tissue (g)	- 0.091 (0.57)	- 0.132 (0.41)	0.104 (0.51)	- 0.021 (0.89)
Fat (g)	- 0.095 (0.55)	0.089 (0.58)	- 0.135 (0.40)	0.001 (0.99)
Lean (g)	- 0.068 (0.67)	- 0.277 (0.08)	0.138 (0.39)	- 0.132 (0.41)
BMD (g/cm²)	- 0.313 (0.04)*	- 0.104 (0.52)	- 0.362 (0.02)*	- 0.081 (0.62)
Male group				
Anthropometric characteristics				
Height (cm)	0.070 (0.64)	- 0.258 (0.08)	0.005 (0.97)	- 0.280 (0.06)
ULL (cm)	0.011 (0.94)	- 0.358 (0.01)*	- 0.107 (0.48)	- 0.184 (0.22)
TCL (cm)	0.052 (0.73)	- 0.177 (0.23)	0.174 (0.24)	- 0.077 (0.61)
LLL (cm)	0.149 (0.32)	- 0.270 (0.07)	- 0.145 (0.33)	- 0.297 (0.04)*
WHR (cm)	- 0.080 (0.59)	- 0.022 (0.88)	- 0.014 (0.92)	- 0.050 (0.74)
Foot size (cm)	0.072 (0.63)	- 0.253 (0.08)	0.041 (0.78)	- 0.256 (0.08)
Foot width (cm)	- 0.020 (0.89)	- 0.105 (0.48)	- 0.073 (0.63)	- 0.282 (0.05)*
Body Composition				
Body mass (kg)	0.108 (0.47)	- 0.070 (0.64)	0.049 (0.74)	0.004 (0.97)
BMI (kg/m²)	0.115 (0.44)	0.045 (0.76)	0.058 (0.70)	0.191 (0.20)
Fat %	0.174 (0.24)	0.029 (0.84)	0.107 (0.48)	0.106 (0.48)
Tissue (g)	0.110 (0.46)	- 0.080 (0.59)	0.047 (0.75)	0.010 (0.94)
Fat (g)	0.157 (0.29)	- 0.011 (0.94)	0.075 (0.62)	0.088 (0.56)
Lean (g)	- 0.018 (0.90)	- 0.093 (0.53)	- 0.037 (0.80)	- 0.125 (0.40)
BMD (g/cm²)	0.014 (0.93)	0.238 (0.13)	0.082 (0.60)	0.215 (0.17)

Spearman's r *$p \leq 0.05$. BMI: Body Mass Index; ULL: Upper Limb Length; LLL: Lower Limb Length; TCL: Trunk-cephalic Length; BMD: Bone Mineral Density; WHR: Waist-to-Hip Ratio.

DISCUSSION

The main finding of the study is that anthropometric variables and body composition interfere slightly in the limit of stability limit and rhythmic weight shift tests. Moreover, sensory information is different between men and women.

In the female group, the reaction time was faster and the larger the foot size, the greater the maximum excursion. In the male group, the narrower the foot, the worse the control of anteroposterior direction, corroborating previous studies[4,11,12,13] which claim that the increase in base of support size improves postural balance. These data are related to a larger area of contact between the feet and the platform surface, and do not necessarily indicate intrinsic changes in balance, especially since there were no changes in movement speeds.[11]

The lower the BMD the greater the movement speed and the worse the control of speed in the mediolateral and anteroposterior directions. These data are similar to a previous study in semi-static condition.[12] Bone quality was positively associated with body composition (lean and fat mass).[14-16] Subjects with higher lean mass generally have a more active lifestyle, with more suitable dietary patterns that can directly affect their bone health and consequently their postural balance.[14,15] This is equivalent to saying that body composition promotes mechanical overload on the bone, inducing the formation of osteoblasts and the piezoelectric effect.[14] In addition, the more lean mass the greater the muscle strength, and therefore the better the muscle contraction, which generates impacts on bone sites producing specific deformations and stimulating bone cells anatomically related to these muscles, also explaining the piezoelectric effect on the increase in bone mass.[17,18]

In the female group, the greater the ULL and LLL, the worse the directional control. In the Rhythmic Weight Shift Test analyses, greater height and ULL also showed worse mediolateral directional control. Limbs generally follow body shape - taller individuals tend to have longer limbs. LLL is related to a greater distance from the center of gravity to the base of support area.[3,12,19] In addition, height increase is accompanied by greater gastrocnemius activity and ankle movements.[20] Height and body mass contribute to the "inverted pendulum" effect, with the ankle joint acting as the pivot in the bipedal posture and the interface between the body and the ground representing the base.[3,20]

In the male group, there was no relationship between the limits of stability variables and the anthropometric factors, a fact that contradicts our hypothesis and other studies, where men, as they are taller, also had a worse postural balance.[4,5,12] The WHR also had a negative correlation with anteroposterior directional control. The concentration of fat mass in the chest and abdomen (android shape) may increase the load on the hips, explaining the greater displacement in the mediolateral direction. The centripetal distribution of fat alters the center of mass, which ends up being greater in android than in gynoid body shapes.[12]

Balance maintenance is a skill acquired and improved throughout life, and therefore involves a natural adaptation to anthropometric parameters and body composition, i.e., the individual learns to maintain postural control over their body and only extreme measurement variations interfere significantly with balance.[4]

In the study population of young adults, without diseases or other abnormalities, anthropometric parameters and body composition had little influence on balance. Considering anthropometric variables in balance studies, in a young population, does not appear to be necessary, with the exception of foot size and longitudinal parameters (height, LLL and ULL). Body mass and BMI can be disregarded, when within normal values.

The methodological limitations are due to the actual multifactorial characteristics of balance. However, the results found reliably show that the anthropometric factors and body composition of a normal population (without extremes) have little influence on results in postural balance.

CONCLUSIONS

Body composition variables do not interfere with the limits of stability and rhythmic weight shift tests in subjects with normal BMI values, with the exception of BMD in women.

Regarding anthropometric parameters, longitudinal measurements (height, LLL) as well as ULL, WHR and foot size in the female and male groups: ULL, LLL and foot size, exert weak influence on the control of postural balance.

All authors declare no potential conflict of interest related to this article

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