Original Article

Can somatotype influence the static postural control? A new proposal of investigation

GIUSEPPE PENNA[1], GIULIO ZECCA[2], GAETANO ALTAVILLA[3], TIZIANA D'ISANTO[4], LUCA RUSSO[2]

[1]*Faculty of Kinesiology. University of Split. Split, Croatia.*
[2]*Department of Human Sciences. Telematic University IUL. Florence, Italy.*
[3]*Department of Biological and Environmental Sciences and Technologies. University of Salento. Lecce, Italy.*
[4]*Department of Human, Philosophical and Education Sciences. University of Salerno. Fisciano, Italy.*

ABSTRACT

Static postural control can be influenced by several aspects, even anthropometric parameters or somatotypes. The aim of this research was to identify the influence of the somatotype on the static postural control and the association between the somatotype and the sagittal posture alignment. Eighty-three subjects (n = 83) were included in the study and were tested for somatotypes, postural sway control and static sagittal postural alignment. The mesomorphs showed a body mass and a BMI significantly higher than the other somatotypes ($p < .0001$); the ectomorphs have shown a postural sway significantly higher than the mesomorphs ($p = .028$). An association between the somatotype and the sagittal posture ($p = .027$) was also measured. The data of this research are partly consistent with previous literature about somatotypes and postural control but data on the postural sagittal alignment offer an innovative perspective. In conclusion, an interaction between somatotypes, sagittal postural alignment and postural sway control is present and health professionals should consider it.
Keywords: Posture, Stability, Balance, Postural assessment, Sports medicine, Sports health.

Cite this article as:
Penna, G., Zecca, G., Altavilla, G., D'isanto, T., & Russo, L. (2023). Can somatotype influence the static postural control? A new proposal of investigation. *Journal of Human Sport and Exercise, 18*(3), 586-595. https://doi.org/10.14198/jhse.2023.183.07

Corresponding author. *Department of Human Sciences. Telematic University IUL. Florence, Italy. https://orcid.org/0000-0003-1902-4830*
E-mail: l.russo@iuline.it
Submitted for publication February 21, 2023.
Accepted for publication March 21, 2023.
Published July 01, 2023 *(in press* April 18, 2023).
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202.

doi:10.14198/jhse.2023.183.07

INTRODUCTION

Posture is generally defined as the relationship among the various part of the body, with particular attention to the upright position. A good posture is considered ergonomically advantageous when standing, mechanically efficient when moving and of support for the normal function of the internal organs (Czaprowski et al., 2018). Postural control or postural stability is the ability to maintain equilibrium and orientation in a gravitational environment (Negahban et al., 2014) . It is also defined as the ability to maintain an upright posture and to keep the centre of gravity (COG) within the limits of the base of support (Jonsson et al., 2004) (Mochizuki et al., 2006). McGuine et al. (2000) have reported higher injury incidence in athletes with poor postural control and it was suggested that balance postural control may be influenced by several aspects such as muscles and proprioception (Raiola et al., 2020) (Esposito et al., 2021), relative position of body segments (Russo et al., 2020) (Giustino et al., 2021) and even anthropometric parameters and somatotypes (Allard et al., 2001) (Farenc et al., 2003). In fact, somatotypes can be considered an overview of the physical characteristics of the human body (Carter & Heath, 1990).

The somatotype is defined as the quantification of the shape and composition of the human body, according to the anthropometric measurements, and it is expressed in a three-number rating in sequence, each between 0 to 9, which correspond to the endomorphy, mesomorphy and ectomporphy components, always in the same order. The endomorphic subject is tendentially predisposed to store fat, the mesomorphic to develop musculature, the ectomorphic to have a thin and slender body. Every individual is a combination of all the three components in different proportions; the rating of each component is considered low below 2.5, moderate from 3 to 5, high from 5.5 to 7 and very high above 7.5. From example, 3-6-2 rating shows a moderate endorphism, a high mesomorphism and a scarce ectomorphism. This classification allows to have a very precise and individualized definition of the somatotype (Carter & Heath, 1990).

Although some studies indicated the association between the somatotypes, health conditions (Makgae et al., 2007) (Mozumdar & Roy 2008) and physical performance (Kolpakov et al., 2009) (Marta et al., 2011), to our knowledge there are few studies that have investigated the influence of somatotype on postural control in association with sagittal postural alignment. Allard et al. (2001) reported reduced postural stability of the ectomorphic group in comparison with the mesomorphic and endomorphic groups. They suggested low muscle component, an elevated position of the body centre of mass, and high height to weight ratio are the main reasons for the poor stability of this population. These results were later confirmed by Farenc et al. study (2003), which showed thinner subjects have larger sway amplitude of the centre of gravity (COG). They found that ectomorphs demonstrated larger horizontal displacements of the COG and concluded that because of their less musculature structures, endomorphs present better postural control than ectomorphs do. In another study, mesomorphs showed significantly smaller movement of centre of pressure (COP) than endomorphs and ectomorphs (Lee & Lin, 2007); authors explained that better single leg postural stability in mesomorphs might be due to the significantly lower body height and higher proportion of muscular profile.

In the light of the scientific background, the aim of the study was to identify the influence of the somatotype on the static postural control and the association between the somatotype and the sagittal posture alignment. The study based on the hypothesis that a relationship between the somatotype and postural alignment and control is rationale.

MATERIAL AND METHODS

Participants

For the research were recruited 120 voluntary subjects, sporty and physically active. Of these, 83 subjects were included in the study, 42 women and 41 men (24 ± 4.4 years, height 171.4 ± 8.5 cm, weight 71.3 ± 15.3 Kg), specifically only the subjects with a somatotype-component dominant as regards the others (Samaei, 2014). Moreover, the subjects with postural problems, injuries and balance difficulties were excluded from the study. All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki.

Instruments

The anthropometric tests were carried out with the following instruments: Harpenden Skinfold Plicometer (Baty International, Burgess Hill, UK), Carbon Fibre Composite Digital Calliper (Hangzhou MeasPro Measuring Tools Co, Hangzhou, China), scale AccuWeight AW-BS001BS (AccuWeight, China), tape measure Seca 206 (Seca, Amburg, Germany).

The postural tests were carried out with the following instruments: FinePix s5600 camera (Fujifilm, Tokyo, Japan), 40x40 foot plantar pressure platform FreeMed (Sensor Medica, Guidonia (RM), Italy), FreeStep v.1 video analysis software (Sensor Medica, Guidonia (RM), Italy).

Details on experimental procedure

Testing was carried out in a Sport Performance Laboratory at a mean temperature of 20°C and a mean relative humidity of 52%, at the same time of the day (10-12 am) according to previous laboratory researches (Russo et al., 2020) (Ardigò et al., 2020) (Russo et al., 2023) (Ardigò et al., 2023). All subjects carried out the tests in minimal clothing in two separate days. The anthropometric measures were carried out in the first day; the postural measures in the second day. In order to avoid differences in the methods of measurement, all tests were carried out by the same researcher and the test sequence was randomized.

Anthropometric measurements

The following anthropometric measurements were calculated for the somatotype (Carter, 2002):

- Height (cm). The measurement was done with a tape measure, with no approximating; the subject standing straight with heels, buttocks, back and nape touching the wall. The head oriented in the Frankfurt plane and a stretch-upward posture.
- Body mass (Kg). The measurement was done with a scale with a 0.1 kg approximation. The subject stands in the centre of the scale in a upright position.
- Skinfold (mm). The measures were always taken on the right side of the body with a skinfold plicometer with a 0.5 mm approximation. For a correct measurement raise a fold of skin between thumb and forfinger placing the calliper perpendicularly at about 1 cm from the skinfold the has to be measured. Allow about 4 sec from the release of the calliper before reading the data.
    a. Triceps skinfold. Posterior vertical skinfold of the arm taken halfway between the acromion and the elbow.
    b. Subscapular skinfold. Diagonal skinfold at 45° just below the lower angle of the scapula.
    c. Anterior suprailiac skinfold. Diagonal skinfold at 45° between the upper horizontal line of the iliac spine and the vertical line of the antero-superior iliac spine.
    d. Calf skinfold. Raise a vertical skinfold on the medial side of the leg, at the level of the maximum girth of the calf.

- Condylar breadth (mm). The measurements were always taken on the right side of the body with a calliper and with an approximation of 0.5 mm.
    e. Diameter of the humerus. With elbow flexed at 90°, we measure the width between the two condyles of the humerus.
    f. Diameter of the femur. With the knee bent at 90°, we measure the width between the two condyles of the femur.
- Circumference (cm). The measurement has always been taken on the right side of the body using a tape measure and with no approximation.
    g. Arm circumference. The subject flexes the elbow to 45° and shoulder to 90°, contracting the elbow flexors and extensors. The measurement is taken at the greatest girth of the arm.
    h. Calf circumference. The subject stands with legs slightly apart. The measurement is taken at the maximum circumference of the leg.

Calculus of the somatotype

Equation to calculate endomorphy (Carter, 2002) = $-0.7182 + 0.1451(X) - 0.00068(V^2) + 0.0000014(V^3)$

V = (sum of triceps, subscapular and anterior suprailiac skinfold) x (170.18/height in cm)

Equation to calculate mesomorphy (Carter, 2002) = 0.858 x humerus breadth + 0.601 x femur breadth + 0.188 x corrected arm circumference + 0.161 x corrected calf circumference – height x 0.131 + 4.5

Corrected arm girth = (flexed arm girth) – (triceps skinfold/10)

Corrected calf girth = (maximal calf girth) – (calf skinfold/10)

Equation to calculate Ectomorphy (Carter, 2002) depends on height-weight ratio (HWR). HWR is calculated as height (cm) / mass$^{1/3}$ (kg).

If HWR $\geq$ 40.75 = 0.732 HWR - 28.58

If HWR < 40.75 and > 38.25 = 0.463 HWR - 17.63

If HWR $\leq$ 38.25 = 0.1

The somatotype has been assigned by combining all of the three indexes (Endomorphic, Mesomorphic, Ectomorphic) contemporaneously.

Postural measurements

Two kinds of procedures were carried out in order to identify the postural characteristics: photographic analysis and stability test.

Photographic analysis of upright posture was performed on the sagittal plane. The subject was standing in a upright position, as natural as possible and sideways from the observer. According to literature classification (Kendall et al., 2005) (Czaprowski et al., 2018), each picture had a qualitative value corresponding to: ideal posture, sway-back posture, lordotic or military posture, flat-back posture, kyphotic-lordotic posture (Figure 1). All the pictures were analysed by the same operator. The qualitative postural assessment was carried out by a skilled and high experienced Kinesiologist, with more than 10 years of practice. Before the testing procedure, the reliability of the operator was tested with two observations in two different weeks and the percentage of agreement was higher than 90%.

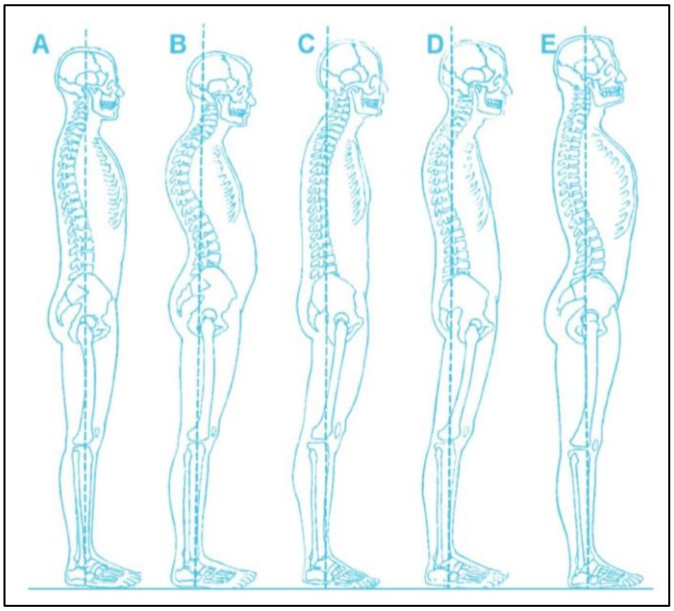

Figure 1. Sagittal posture classification. A. Ideal posture; B. Sway-Back posture; C. Military posture; D. Flat back posture; E. Kyphotic-Lordotic posture. Image modified by Russo et al with permission.

Stability test was performed in bipodalic stance with open eyes, standing still for 51.2 seconds, heels parallel with a 2 cm gap, forefeet 15° outward, arms on the side and looking forward according to previous research (Russo et al., 2015).

Data processing methods

Before proceeding with the statistical analysis, the distribution normality of the data with Shapiro-Wilk's test and the variance homogeneity with Levene's test was calculated. The anthropometric measurements and the postural sway were compared among the groups by means of the one way ANOVA. Tukey's post hoc test was carried out to identify the groups that were statistically different from each other because homogeneity of variances was verified. The components of endomorphism, mesomorphism and ectomorphism were also compared with one way ANOVA. Dunnett's post hoc test was used to identify the groups that were statistically different from each other because homogeneity of variances was not verified. In order to identify the association between the somatotype and the sagittal posture we used the Chi-square test. For all the tests $p < .05$ was taken as the statistical significance indicator. The SPSS 17.0 (SPSS Inc, Chicago, IL, USA) software was used for the analysis.

RESULTS

After the somatotype rating, all the participants were grouped according to the somatotype-component with the highest rating (Figure 2): endomorphy group (n = 25; 21 women; 4 men), mesomorphy group (n = 48; 11 women; 37 men), ectomorphy group (n = 10; 10 women; 0 men). Table 1 presents the anthropometric measurements, the postural sways and the somatotype components of the participants. According to the analysis, the mesomorphs showed a body mass and a BMI significantly higher than the other somatotypes ($p < .0001$) and a significantly higher height as regards the endomorphs ($p = .002$). The ectomorphs have shown a postural sway significantly higher than the other somatotypes ($p = .028$).

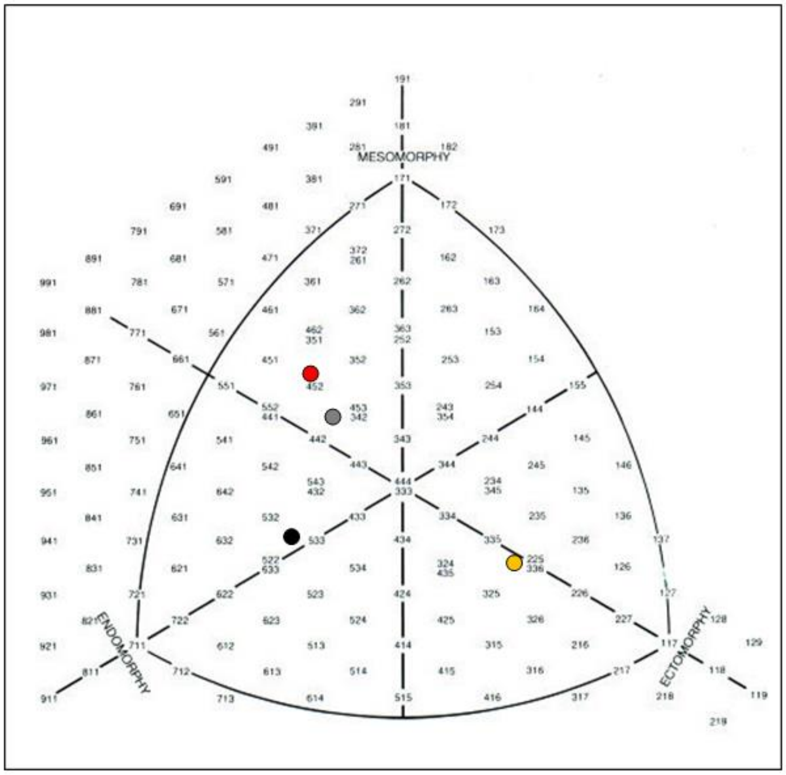

Figure 2. Somatotype classification. Grey dot. Average values for whole sample; Black dot. Average values for Endomorphy group; Red dot. Average values for Mesomorphy group; Yellow dot. Average values for Ectomorphy group.

Table 1. The mean and standard deviation of anthropometric measurements, postural sways and somatotype components for all participants.

	All subjects (n = 83)		**Endomorphs (n = 25)**		**Mesomorphs (n = 48)**		**Ectomorphs (n = 10)**			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Somatotype F-values	ANOVA *p*-value
Age (years)	23.9	4.4	22.6	3.6	24.5	4.8	24.2	3.3	1.473	.235
Height (cm)	171.3	8.4	166.9	7.8	173.9	8.5	169.8	5.9	6.824	.002
Body mass (kg)	71.1	15.4	68.8	16.7	75.9	13.1	53.7	5.4	11.354	<.0001
Body Mass Index (kg/m^2)	24.0	3.8	24.5	4.4	24.9	2.9	18.6	1.0	15.574	<.0001
Postural Sway (mm)	396.7	74.1	397.0	57.0	384.8	78.2	452.9	71.8	3.728	.028
Endomorphic	3.8	1.6	5.4	1.5	3.9	1.2	2.0	0.8	29.343	<.0001
Mesomorphic	4.4	1.5	3.2	1.2	5.1	1.1	1.8	0.7	42.819	<.0001
Ectomorphic	2.2	1.1	2.9	0.3	1.8	0.4	4.5	0.7	56.138	<.0001

An association between the somatotype and the sagittal posture (*p* = .027) was also measured. Table 2 shows the percentage of association (%) between the somatotype and the sagittal posture. In the endomorphs group a majority of subjects had a flat back posture (40%). In the mesomorphs group the subjects with a Kyphotic-Lordotic posture were (31.3%), followed by those with the Ideal posture (27.1%). In the ectomorphs group there prevailed in some way the subjects with Sway-back posture (30%), Kyphotic-Lordotic posture (30%) and a Flat back posture (30%), followed by the remaining subjects classified as having the Military posture (10%).

Table 2. The percentage of association between the somatotype and the sagittal posture.

	All subjects (n = 83)	**Endomorphs (n = 25)**	**Mesomorphs (n = 48)**	**Ectomorphs (n = 10)**		
Sagittal Posture Classification	n (%)	n (%)	n (%)	n (%)	Pearson Chi-Square	*p*-value
Ideal posture	19 (22.9)	6 (24.0)	13 (27.1)	0 (0.0)	17.288	.027
Sway-back posture	8 (9.6)	1 (4.0)	4 (8.3)	3 (30.0)		
Military posture	16 (19.3)	4 (16.0)	11 (22.9)	1 (10.0)		
Flat back posture	18 (21.7)	10 (40.0)	5 (10.4)	3 (30.0)		
Kyphotic-Lordotic posture	22 (26.5)	4 (16.0)	15 (31.3)	3 (30.0)		

DISCUSSION

Body types and somatotypes are important factors that might affect the ability of balance control and the quality of postural sway (Farenc et al., 2003). Although several studies have investigated the effect of somatotype on the physical performance (Berg et al., 1998), little attention was paid to the somatotype influence on the static postural control (Allard et al., 2001) (Czaprowski et al., 2018). Our results revealed that in comparison to endomorphs and mesomorphs, postural sway is increased in the ectomorphic subjects during static balance test. Our findings were consistent with the Allard et al. (2001) and Farenc et al. (2003) studies, which reported that ectomorphs presented the worst balance control in comparison to the other somatotypes, at the same time other researchers showed higher postural sway for endomorphs (Samaei et al., 2014). The results of the present study may indicate that ectomorphs, with lower body weight and less muscle mass, have more difficulty to control balance than endomorphs and mesomorphs. Our study also confirmed some of the results by Lee and Lin (2007), who showed the better postural control in mesomorphs in comparison to the other somatotypes; on the other hand, mesomorphs with higher muscle mass might have better postural control than endomorphs and ectomorphs. However, previous results indicated the same quality of balance control in endomorphs and ectomorphs (Lee & Lin, 2007), and this is opposed respect our findings, which indicated better balance control by endomorphs than by ectomorphs. These differences between the results might be related to higher muscle mass and better height to weight ratio in endomorphs in comparison to the ectomorphs (Allard et al., 2001). Our results also showed an association between somatotype and sagittal posture. However, our study is not comparable to the other studies at least regarding the postural classifications: Ideal, Sway-back, Military, Flat back and Kyphotic-Lordotic (Kendall et al., 2005). The use of the postural classification and its connection with somatotype is the main novelty of this research because it gives a new perspective in postural assessment process. Professionals should also consider the somatotype when a postural assessment is performed and vice versa. Although our research was focused on young adults, the results are consistent with other authors suggesting that the somatotype affect the sagittal posture in schoolchildren, with stronger associations in older age (Araújo et al., 2014) (Araújo et al., 2017).

Some limitations of this work should be highlighted. Although sagittal posture observation is the simplest available method for postural evaluation (Perry et al., 2008), radiographies directly allow us to measure spinal curvatures and are the gold standard which would have allowed more robust conclusions. Another limitation is the absence of dynamic measurement of the subjects' motion. It would have given more information on the effect of the relationships founded in the present research. Finally, the sample of this research was constituted by sporty and physically active individuals, in fact the average values of the whole sample was classifiable with meso-endomorphic characteristics. The results of the present research can be specific for this cluster of people and no definitive conclusions can be provided for sedentary or malnourished individuals. Therefore, future researches are needed to confirm our results and the extend them to other clusters of individuals.

CONCLUSION

The present study revealed that the sagittal posture and static balance control in young adult might be influenced by the somatotype. At the moment contrasting results are present in literature but according to the results of this study, it might be concluded that ectomorph subjects are at higher risk of injury during sports activities and daily life, because of higher postural sway. According to these findings, prescribing specific balance exercise training for ectomorphs before participating in any type of sports activities is recommended. Moreover, it might be suggested to check for body composition and somatotype when an overall evaluation of posture is performed, in order to have a clearer point of view of the subject health status.

AUTHOR CONTRIBUTIONS

Conceptualization: L. R., and G. Z. Methodology: L .R. Formal analysis: G. P., and L. R. Investigation: G. Z. Data curation: G. P., and L. R. Writing—original draft preparation: G. P. Writing—review and editing: G. P., and L. R. Visualization: G. A., and T. D. Supervision: L. R. Project administration: G. A., and T. D. All authors have read and agreed to the published version of the manuscript.

SUPPORTING AGENCIES

No funding agencies were reported by the authors.

DISCLOSURE STATEMENT

No potential conflict of interest were reported by the authors.

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