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ORIGINAL ARTICLE

# Is postural asymmetry associated with emotional stability in healthy subjects? A preliminary study

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**Abstract**
*Purpose* Considering that musculo-skeletal system and nervous system reciprocally are connected by the presence of proprioceptors and interoceptors, the aim of this study was to investigate the relationship between emotional stability and posture.
*Methods* We recruited 100 healthy volunteers (age 30.2 ± 9.8 years) who regularly practiced physical activity, and we evaluated posture (vertical line of Barrè) and emotional stability (a specific component of the Big Five Questionnaire—BFQ). Chi-square test was used to evaluate the distribution of the postural evaluation by sex. ANOVA with Bonferroni correction was used to evaluate the differences of the BFQ in the groups of Barrè (ascending, descending, mixed, and disharmonic). A multiple regression models was set to assess the factors related to gender, age, and posture. $P < 0.05$ was considered significant.
*Results* In 86 subjects, we found asymmetric posture expressed by malalignment of the Barrè line with respect to the median line. Control of Emotion did not differ between the different groups in Barrè assessment test ($p = 0.07$), but for Impulse Control, there were significant differences between mixed and descending and between mixed and neutral posture ($p = 0.03$). In emotional stability, we observed significant differences between mixed and descending and mixed and neutral ($p = 0.02$). The subjects who had greater control of emotions and impulses had a mixed or a descending-type posture of the vertical evaluation in the Barrè test ($p < 0.01$).
*Conclusions* Emotional stability was associated with postural adjustment, affecting, in particular, the cervical spine and legs. We could hypothesize that symmetrical posture is not necessarily related to psychological balance, while asymmetric posture may represent a sign of good control of emotions and impulses.

**Keywords** Posture · Impulse control · Emotional stability · Emotional control

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## Introduction

Posture is the human body position in space and the relationship between the body segments [1]. It guarantees the anti-antigravity functions with the least energy expenditure while walking and while stationary; it contributes to various aspects of the person's psycho-physical well-being (neurophysiological, biomechanical, emotional, psychological, and relational factors) [1]. Each body part has its centre of mass: each segment making a composite centre of mass which, in turn, creates a centre of gravity that guarantees the maintaining of body balance with minimal expenditure of energy [2]. Over the years, several posture definitions and assessment methods have been proposed

[3, 4]. Dega [5] suggests studying posture not only analysing the vertical alignment of the torso, but also the head, the lumbar spine, the pelvis, and the feet. To preserve equilibrium, pathological postures (i.e., kyphosis–lordosis, flat back, or sway-back) could determine compensatory responses of other parts of the body resulting in stress on the neurological system and muscular strains [6, 7].

Body and mind are intimately connected and affect each other. Personality is the set of psychological and behavioural mode characteristics (inclinations, interests, and passions) that define individual differences. The 'Big Five' is a test to study personality and is based on five factors or dimensions: extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience (or intellect) [8, 9].

Considering that the posture may be an adaptation to emotional, psychological, and relational conditions, previous studies [6, 10, 11] analysed the correlation between personality and posture, showing that an introverted personality is linked to scoliosis and flat back, while an extroverted personality is correlated with a kypho-lordotic posture [10]. In fact, Guimond and Massrieh [10] showed an influence of the quantitative variations of neurotransmitters, trophic factors, and hormones on muscle activity (and hence the postural response), mood, stress, anxiety, and depression. Happy feelings determine upright postures, while sad feelings induce curved positions [12]. On the other hand, upright posture can alleviate depression by improving breathing: the increase of oxygen levels in the blood allays muscular tension in the shoulders [12]. In addition, qualitative changes in motorial behaviour (such as facial expressions or posture) may be the response to emotions, through intrinsic connections between brain and proprioceptive input [12]. These previous studies [10–12] demonstrate that there is a relationship between the parts of the whole, and the whole should not be understood simply as segments of the body, but also how the mind and body are themselves correlated. Considering that the bioenergetics theory of Lowen [13] showed that a person who develops muscle tension shows greater emotional stability (this difficulty to externalize emotions is defined as "character armour"), we hypothesized possible postural adjustments in response to emotional stability. To our knowledge, the relationships between posture and each component of personality have not yet been investigated, and for this reason, the aim of this preliminary study was to find the relationship between the postural evaluation and the evaluation of only emotional stability [14]. In accordance with the literature, since emotions could affect postural abnormalities, we assumed that there may be an association between the emotional sphere and the posture [14]. The hypothesis is that postural imbalance may create emotional stress just as emotional imbalance may determine reactive postural adjustments. We also hypothesized that there may be a difference between males and females as regard postural adjustments to emotions, given the differences in muscular mass between the two genders.

## Methods

### Participants

We recruited 100 (50 males and 50 females; age 30.2 ± 9.8 years; weight 72 ± 4.3 kg; height 174 ± 7.4) healthy volunteers >18 years, who practiced regular physical fitness activities. Participants were screened to exclude asymmetry of the legs, scoliosis, or spondylolisthesis, evidenced by X-ray. Considering that X-rays had previously been carried out, but were not homogeneous, they were not included in the study.

### Experimental design

The local Institutional Review Board approved the study designed to investigate the relationship between the postural evaluation and the evaluation of emotional stability. The study was conducted ethically according to international standards [15]. Postural and psychology evaluations were administered on 1 day between 4.00 and 6.00 p.m. These evaluations were carried out in the same sequence and with 10 min of rest between each one. All assessments were carried out by an accredited doctor, in a medical room with a controlled temperature and without noise or distractions. The following exclusion criteria were used: a history of asymmetry of the legs, scoliosis, or spondylolisthesis, previous surgeries of the lower limbs, column, or abdomen, and the presence of a hypertrophic scar in the these locations.

All participants were adequately informed about the study and gave their written informed consent.

### Measurements

#### *Vertical test*

The subjects were evaluated for a postural assessment that included the non-invasive and ecological vertical test of Barrè [16] on the back (Fig. 1).

The postural evaluation was carried out in a static position using a digital camera to capture the necessary images. The markers used for the postural evaluation were equipped with a hypoallergenic adhesive, decreasing the possibility of an allergic reaction. Beginning at the marker placement station, the subjects were instructed to wear tight-fitting clothing, such as a swimsuit, for easy

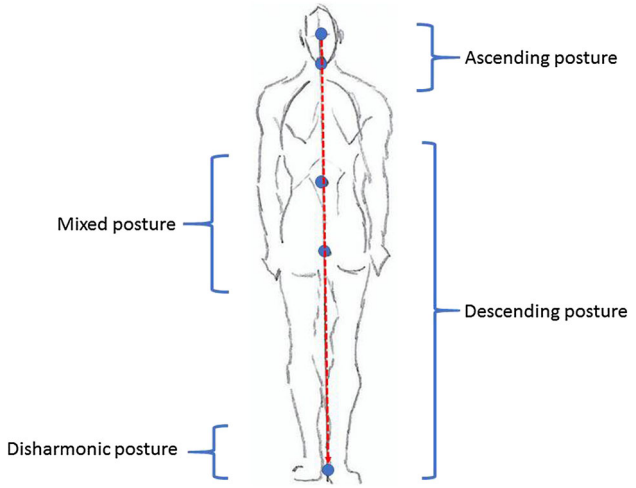


**Fig. 1** Scheme of postural assessment with vertical line of Barrè

application of the markers [17, 18]. During the processing, the photos were viewed and zoomed 200%, and image calibrations were performed using the plumb line as a reference and, based upon the anatomical marks, the *x* (horizontal) and *y* (vertical) coordinates. For the intrarater reliability analyses, 30% of the photos were randomly analysed twice by the same investigator within a 1-month interval. For each participant, photographs were analysed. In posterior view, there was traced a virtual vertical line ideally starting from the medial line (Barrè line) which joined the marker of the occipital part, the spine process of C7, the lumbar vertebra (L3), the intergluteus line, and the middle of intermalleulus ankle distance. When the Barrè vertical line completely overlapped all the markers, we defined the posture as neutral. When there was discordance between the Barrè line and one marker or more, we defined the posture as ascending, descending, mixed, or disharmonic (Fig. 2).

The posture was defined ascending when the Barrè line overlapped only the occipital and cervical markers; the posture was descending when the Barrè line overlapped only the lumbar, intergluteus, and intermalleulus markers; the posture was mixed when the Barrè line overlapped only lumbar and intergluteus markers; and the posture was disharmonic when the Barrè line overlapped only the intermalleulus marker [19, 20].

*The Big Five Questionnaire*

A psychologist asked the subjects to answer the questions relative to emotional stability in the "Big Five Questionnaire" (BFQ) [21]. This psycho-diagnostic test contained 24 questions, with items both negative and positive (for example, "I seem to be an active person", "I'm not very attracted to new situations"), to assign a value from 1 to 5

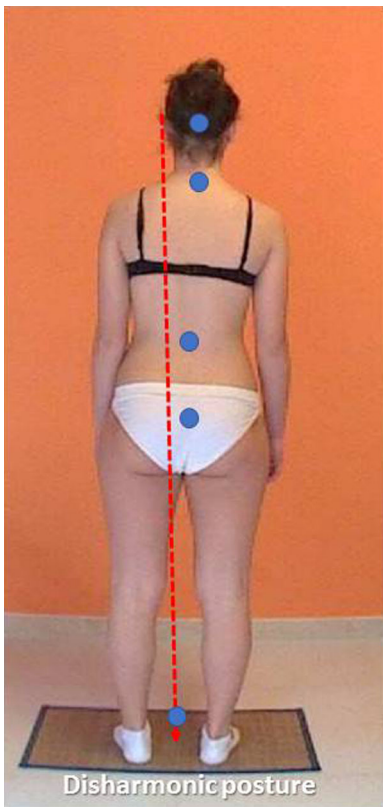


**Fig. 2** Evaluation of a subject with a disharmonic posture

according to the Likert scale (1 = absolutely false to 5 = absolutely true). In addition, there is a lie (*L*) scale designed to measure a social desirability response and the tendency to distort meanings of the scores. The *L* scale contains 12 items that are all positively phrased.

The questionnaire measures five personality traits, and the Cronbach's alpha coefficients were [22]: 0.82 for extraversion, 0.76 for agreeableness, 0.83 for conscientiousness, 0.91 for emotional stability, and 0.77 for openness. As regard the emotional stability (SE) (range 24–120), its two sub-scales are: impulse control (CI) (range 12–60) and control of emotions (CE) (range 12–60). The forms were put into a database created with Stabylopro version 3.0 (Bosco System diagnostics; Italy). A psychologist was present to explain and resolve any doubt regarding the questionnaire.

## Statistical analysis

Continuous variables (age, results of the BFQ) were expressed as mean and standard deviation. Categorical variables (distribution of postural evaluation results) were expressed as proportions. To evaluate the distribution of the postural evaluation by sex, the Chi-square test was used. To evaluate the differences between the averages of the results of the BFQ in the groups of Barrè, identified on

the basis of the postural evaluation, an ANOVA was performed with Bonferroni correction. The confounding factors can affect the relationship between the outcome and the determinant and kept under control through the use of multivariate models. To assess the possible confounding factors relating to gender, age, and posture, three multiple linear regression models were set. In each model, the outcome was, respectively, CE, SE, and CI, while determinants, in the three models, were gender, age, and groups of Barrè (ascending, descending, mixed, and disharmonic). All postures that are different from the neutral ones are "postural abnormality", a "less flexible and relaxed posture", and "altered posture". Interclass correlation was used for the intrarater reliability analysis of photomeasurements (mean ICC value of every measurement = >0.9). There was no physiological range or pathology. Depending on whether the result value is higher or lower, it will express a greater or lesser emotional stability. For all analysed tests, a value of $p < 0.05$ was considered significant.

## Results

As regard the age, there were no significant differences ($t = 0.81$; $p = 0.20$) between males (31.0 ± 12.2 years) and females (29.4 ± 6.4 years). With regard to the results of the BFQ test, the mean value of the total CE was 37.9 ± 8.2, the mean value of total CI was 36.5 ± 7.3, and the mean value of total SE was 74.4 ± 13.7. The average values of the CE score did not differ by splitting the sample results of the Barrè assessment test ($F = 2.26$; $p = 0.07$; Fig. 3).

As regard the results of the evaluation of the vertical line of Barrè, 48 subjects were descending, 20 ascending, 14 neutral, 10 mixed, and 8 disharmonic. The distribution of the results of the evaluation of Barrè showed statistically significant differences by gender. Among women descending was more frequent than disharmonic and neutral (Table 1; Chi square = 6.27; $p = 0.18$).

**Table 1** Distribution of the results of the evaluation test of Barrè, by gender

| | Female | Male | Total |
|---|---|---|---|
| Ascendent | 10 | 10 | 20 |
| Discordant | 2 | 6 | 8 |
| Descendent | 30 | 18 | 48 |
| Mixed | 6 | 4 | 10 |
| Neutral | 2* | 12 | 14 |

* $p < 0.05$

Distribution of the Big Five test results in relation with the rotation of the pelvis is presented in Table 2.

As regard the average values of total CI, the ANOVA showed differences between mixed and descending and between mixed and neutral posture ($F = 4.4$; $p = 0.026$; Fig. 4).

In addition, as regard the value of the total SE, we observed differences between mixed and descending and mixed and neutral ($F = 3.43$; $p = 0.016$; Fig. 5).

The multiple linear regression model showed that an ascending posture was influenced by age ($t = 3.10$;

**Table 2** Distribution of the Big Five test results in relation with the rotation of the pelvis

| | Symmetric Mean ± SD | Non-symmetric Mean ± SD | *t* | *p* |
|---|---|---|---|---|
| CE | 39.8 ± 7.5 | 37.7 ± 8.2 | 0.8 | 0.39 |
| CI | 36.4 ± 7.3 | 36.8 ± 7 | 0.18 | 0.86 |
| SE | 76.7 ± 12.4 | 74.1 ± 13.8 | 0.61 | 0.55 |

The data are expressed as mean and standard deviation

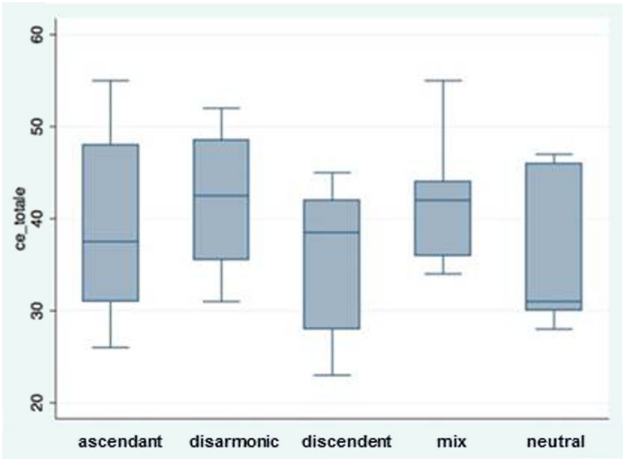


**Fig. 3** Average total EC values for the result of Barrè assessment test

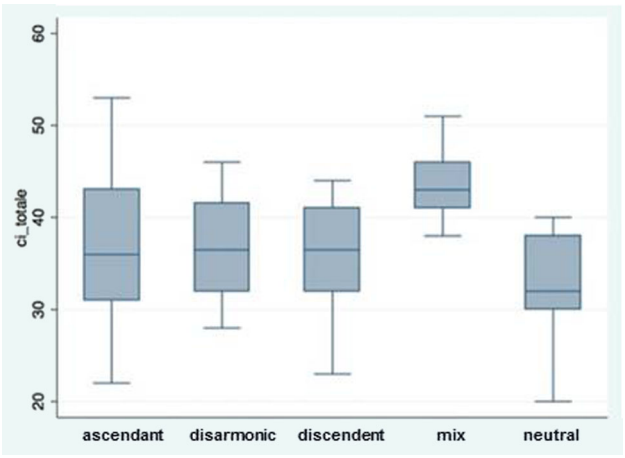


**Fig. 4** Average total CI values for the result of Barrè assessment test

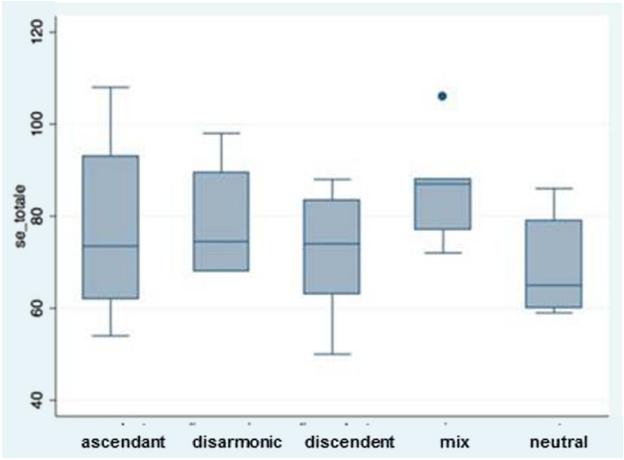


**Fig. 5** Average values of total SE, for the result of Barrè assessment test

$p = 0.02$), that the mixed posture was influenced by CI value ($t = 2.66$; $p = 0.008$), and that the neutral posture was influenced by gender ($t = 2.66$; $p = 0.008$). The total value of CE was affected by the male gender ($t = 4.11$; $p < 0.0001$), ascending ($t = 3.34$; $p = 0.001$), disharmonic ($t = 2.56$; $p = 0.012$), or mixed posture ($t = 5.3$; $p = 0.003$). The total value of CI was, however, influenced by ascending ($t = 3.47$; $p = 0.001$), disharmonic ($t = 2.31$; $p = 0.023$), descending ($t = 2.70$; $p = 0.008$), or mixed posture ($t = 4.2$; $p < 0.0001$). The value of the total SE was influenced by male gender ($t = 2.44$; $p = 0.017$), ascending ($t = 3.86$; $p = 0.001$), disharmonic ($t = 2.76$; $p = 0.007$), descending ($t = 2.60$; $p = 0.011$), or mixed posture ($t = 4.1$; $p < 0.0001$).

## Discussion

Considering that the mind and body are each part of a whole and, as such, influence each other [8], the purpose of this study was to verify a possible bi-directional relationship between the psychological aspect and the body with particular attention to emotional stability and its components (i.e., the control of emotions and impulse control) and the types of posture. Our results showed that 14% of the subjects had postural abnormalities, which is in agreement with the literature [23], and revealed a relationship between an emotional stability and a less flexible and relaxed posture. A personality trait with good emotional stability is associated with more postural adjustments, affecting, in particular, the cervical spine and legs [14]. In the literature, it has been shown that there is an bi-directional relationship between moods on postural abnormality. Rosário et al. [14] found a correlation between anger and postural abnormalities such as shoulder inclination, protrusion of the head, knee hyperextension, and elevation of the shoulders. In addition, depression and sadness can influence the inclination of the head and the shoulders [24]. It has also been demonstrated that there is a relationship between protraction of the shoulder and sadness [24].

The level of stress can influence postural stability [25]. Moreover, high levels of cortisol are associated with poor executive function, abstract reasoning, processing speed, and visual–spatial memory [26, 27]. These correlations between emotion and posture are supported by the hypothesis that states of mood, such as fear and anxiety, strategies of anticipation, loss of balance, and balance control [28–35].

Furthermore, first, Darwin [36] and James [37] and then Damasio et al. [38, 39] hypothesized that posture can determine emotions: the interoceptors (the inputs that gather thermic, metabolic, and hormone body information) and proprioceptors (the inputs from muscle and joints) transmit information to the brain that translates into unconscious emotional states and conscious subjective feelings.

Until now, no particular attention has focused on the correlation between control of emotion and posture. Our results showed that subjects who had greater control of emotions and impulses presented an altered posture (mixed-type posture or descending type). Moreover, we found a gender difference in posture, with a male gender advantage for neutral posture. These data are in agreement with hormonal differences, body composition, and muscle tissue type that mostly protect the male gender from functional imbalances and degeneration of lumbar back muscle, which may be responsible for postural alterations [40].

Considering that the cause of descending posture is to be found above the centre of mass, while for mixed posture, the cause could also be an imbalance below the centre of mass, we may hypothesize that muscular adjustment takes place principally in the soma, somato-gnathic, and podalic complexes. It is important to highlight that both modified postures were characterized by an imbalance of cervical spine alignment. This aspect is in agreement with the psychophysical method, developed by Frederick Matthias Alexander [41], that underlines the crucial role of head and neck in control of posture [42].

Subjects with less control of emotions and impulses did not present postural alterations (neutral posture). This finding is interesting as it is contrary to the common belief that proper posture is associated with a more stable personality [10]. This misconception was born from the conviction that a personality that is less flexible and adaptable could correlate with a posture that is asymmetric posture, according to Kendall, who reported that the

muscles are more relaxed and less contracted in the ideal posture [43]. Our data may be in agreement with the bioenergetics theory of Lowen [13].

The fundamental thesis of Reichian therapy is to identify the relationship between functional muscular armour and behavioural armour, or between the physical behaviour of a person and the structure of their ego [44]. Reich relates the inhibition of emotional reactivity to the contraction of breathing. Already in 1955, Reich observed that the resistance to the analytic process is manifested physically in the form of a block of unconscious respiration. When the subject stops breathing and so restricts oxygen intake, this dampens the metabolic processes of their body and depresses energy levels and suppresses emotions. Besides the effects on the metabolism, restricting breathing also reduces the natural mobility of the body [45]. The respiratory movement fluctuates like a wave through the body; this wave is moved upwards with inhalation and downwards with exhalation. Muscle spasticity or tension in any part of the body affects breathing, because breathing is total body activity. A block of the temporo-mandibular joint, as a voltage level of the gluteal muscles, reduces the breathing movements and limits the amplitude of inhalation.

The main limitation of the study is the lack of a control group of subjects suffering from dysmetria or paramorphism. Further studies should analyse the remaining four components of personality designed by the BFQ. The strengths of this preliminary study are the novelty of the topic being studied in-depth and the large number of participants with similar age. For these reasons, further large-scale studies are recommended to ascertain the relationship between postural asymmetry and emotional stability in healthy young subjects, considering other emotional parameters as extraversion, agreeableness, conscientiousness, and openness.

## Conclusion

Posture and emotional stability are strictly connected. As we reported about the bi-directional relationship between the mind and the body, in the same way, the mind–body–behaviour relationship is an inseparable triad, as a result of a connection between physical and mental armours. The analysis of the preliminary results of this study allows us to verify that the asymmetrical postures are connected to greater emotional stability. We began with the hypothesis of a bi-directional and reciprocal relationship between posture and emotion. Our preliminary results suggest that postural alteration has a significant effect on emotional stability: physical reactions (e.g., muscle contractions, changes in respiratory rate, heart rate, temperature, pressure, hormone secretion, etc.) determine adjustments of personality trait with good emotional stability. Further and larger studies should investigate more deeply the effects of emotions on posture.

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**Compliance with ethical standards**

**Conflict of interest** All authors declare that they have no conflicts of interest and that they have no competing interests in relation with this manuscript.

**Ethical standard** Research was conducted ethically according to international standards.

**Informed consent** All subjects gave written informed consent to participate in this study.

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