INFLUENCE OF ANTHROPOMETRIC MEASURES ON COP-BASED PARAMETERS OF BODY SWAY

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INTRODUCTION

Nowadays measures of postural ability by dynamometric platform are very common in clinical practice. By this technique it is possible to calculate the displacement of the COP (Centre of Pressure, i.e. the application point of the foot-to-ground reaction force) during experiments with a variety of different set-ups. Several measures were proposed in literature for describing the COP motion. They can be either summary statistic scores directly computed from COP time-series *[1]* or new stochastic parameters recently proposed in literature *[2]*, *[3]*.
The aim of our study is to investigate the influence of the main anthropometric measures on all such parameters during quiet standing.

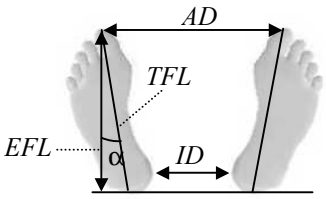
METHODS

In this preliminary experimental session we considered data from 17 subjects (9 male and 8 female), aged 21-29 years (23.7 ± std 2.68). Normal-bodied subjects were selected in order to cover a sufficiently wide range of anthropometric properties (see Table below).

measure	*mean*	*std*	*range*
Weight (kg)	64.8	16.6	44.7-99.8
Stature (cm)	169.8	10.5	151-188
Trunk-height (cm)	50.8	4.3	43-58

Each subject was requested to stand on the dynamometric platform in a stationary upright stance, in the most comfortable way with free foot placement. Subjects were instructed to look at a small circular target (∅=3 cm), placed at eye height, about 1.5 m from the platform. Romberg test was performed, i.e. trials were carried out with both eyes open (*EO*) and eyes closed (*EC*).

Each experimental session was composed of four tests, two *EO* and two *EC*. During posturographic recordings, each consisting of a 50 s acquisition, COP coordinates were measured by a multi-component strain gage force platform (Bertec Corporation) and sampled at a frequency of 20 Hz. The list of measures and parameters follows.
Anthropometric measures (AM): 1) weight 2) stature 3) legs length (malleolus –greater trochanter) 4) trunk length (shoulder-greater trochanter) 5) chest circumference 6) waist circumference 7) hip circumference.
Foot placement measures (FPM): measured by footprint. For description see figure below.



$$BOS = \frac{(AD + ID) \cdot EFL}{2}$$

$$\cos\alpha = \frac{EFL}{TFL}$$

COP-based parameters (CP): 1) summary statistic scores (*mdist, rdist, totex, range, mvelo, area_cc, area_ce, area_sw, mfreq, fd, fd_cc, fd_ce, prd, rd, f50, f95, cfreq, freqd*) *[1]*. 2) stochastic parameters adapted from Collins *et al.* (H_s, K_s, H_l, K_l) *[4]*. 3) sigmoid stochastic parameters (K, Δt_c) *[3]*.
The parameters were calculated from the bidimensional and one-dimensional time-series (Anterior-Posterior and Medial-Lateral COP displacement).
The first step was to look for the monotonic association between each possible couple of variables in terms of ranks (Spearman-rank correlation analysis). Afterwards, we tried to establish linear relationships among the *AM* and *FPM*, considered as independent variables, and all the *CP*, considered as dependent variables. In order to do that, a multiple linear regression model was used.

RESULTS AND DISCUSSION

First, only two independent measures into the anthropometric set are put in light. On the basis of a 0.8 threshold for r, stature and trunk length are considered uncorrelated. Actually it is not completely clear why the trunk length is poorly correlated with total height (r=0.68, p=0.02), but this could be investigated only with a greater population. It is verified that BOS and cos(α) are not correlated, either. Moreover none of the *CP* is significantly correlated with each of the *AM* and *FPM*. For this reason the multiple regression analysis is applied to test the dependence of any *CP* on subject characteristics. We consider that a multiple linear correlation exists when the squared correlation value is higher than 0.95. Overall results are shown in Table1. The parameters listed are those for which a multiple linear correlation is significant.
In this case, the joint use of stature and trunk length establishes several relationships with *CP*. This can lead to think that a two-segment model (hinged at the hip joint) can somehow describe and predict better than the one-segment model (total height) some instances of the postural behaviour of the body during upright stance. No significant differences are noticed between the *EO* and *EC* experiments. All the parameters correlated with the *AM* are correlated with the *FPM*, but not viceversa. In particular, *cfreq-ML* and *range-AP* and *planar* are correlated only with the *FPM*. This is an important point because it suggests that foot position can hardly influence the results of postural experiments if they are quantified by the *range* values, as it often happens.

SUMMARY

The present preliminary results show that some care should be taken, in perspective, when quantifying postural sway through *CP*, in order to address the dependence, that here comes to light, with *AM* and *FPM*. For this reason the choice of a standardized foot placement and the measurement of the main anthropometric features could help in data interpretation and comparison among different subjects. Moreover, the regression equations identified for 10 out of 18 summary statistics and 3 out of 6 stochastic parameters might become informative about what we actually measure by these parameters. Nevertheless, it is remarkable that the stochastic parameters proposed in *[3]* are unaffected by either *AM* and *FPM*.

REFERENCES

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Table 1: Significant results obtained through multiple linear regression

Dependent parameter (R^2>0.95)	Components			Conditions		*AM* (stature, trunk length)	*FPM* (BOS, cos(α))
	Planar	*AP*	*ML*	*EO*	*EC*		
totex	✓	✓		✓	✓	*YES*	*YES*
mvelo	✓	✓		✓	✓	*YES*	*YES*
f50	✓	✓		✓	✓	*YES*	*YES*
f95	✓	✓	✓	✓	✓	*YES*	*YES*
freqd	✓	✓	✓	✓	✓	*YES*	*YES*
cfreq	✓	✓		✓	✓	*YES*	*YES*
cfreq			✓	✓	✓	NO	*YES*
fd	✓			✓	✓	*YES*	*YES*
fd_cc	✓			✓	✓	*YES*	*YES*
fd_ce	✓			✓	✓	*YES*	*YES*
range	✓	✓		✓		NO	*YES*
H_s	✓			✓	✓	*YES*	*YES*
K_s	✓			✓	✓	*YES*	*YES*
K_l	✓				✓	*YES*	*YES*