# ANTHROPOMETRIC AND POSTURAL CONTROL INTERACTIONS DURING SHOOTING

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## Introduction

- Recoil is the effect produced on humans by a shooting task: it provokes an external perturbation on the postural control that can induce the COP to exit from the base of support thus implying the risk of falling.
- Several studies focused on the importance of postural balance as a key for success for the shooting performance and training (Ball, 2003; Era, 1996; Fong, 2000). But the question arises if and how the human anthropometry influences the postural control during a shooting task. Different studies (Alonso, 2012; Carvalho, 2015; Chiari, 2002) investigated the correlation between one or more anthropometric variables and postural stability.
- Some authors identified a relationship between the Sway Path and the Mean Velocity as a cost function weighting the adjustment interventions implemented by the postural control system to maintain the stability (Corbeil, 2003). However, no previous studies investigated the relationship between anthropometric variables and postural control during a shooting task.

## Methods

**DATA ACQUISITION:**

- 18 Subjects (age=21 ± 2 years)
- Body Mass (kg), Height (cm), and Shoes Size (in European Size).

| Subject | Shoes Size(EU) | Body Mass(kg) | Height (cm) |
|---|---|---|---|
| 1 | 42 | 79,85 | 174 |
| 2 | 42 | 82,05 | 180 |
| 3 | 42 | 92,40 | 192 |
| 4 | 41,5 | 74 | 182 |
| 5 | 42 | 78,85 | 184 |
| 6 | 40 | 64,4 | 172 |
| 7 | 42 | 71,4 | 175 |
| 8 | 43 | 92,75 | 171 |
| 9 | 44 | 84 | 175 |
| 10 | 43 | 94,05 | 193 |
| 11 | 43 | 77,6 | 184 |
| 12 | 43 | 66,7 | 182 |
| 13 | 43 | 84 | 183 |
| 14 | 43 | 72,7 | 182 |
| 15 | 44 | 68,3 | 176 |
| 16 | 46 | 97,6 | 199 |
| 17 | 45 | 85,75 | 193 |
| 18 | 45 | 96,95 | 178 |

**Tab. 1**: anthropometric data of 18 subjects

**PROTOCOL:**

- Participants were required to fire 6 shots for 6 shooting sessions at a target placed 7 meters far.
- Posturographic data (COPX, COPY, Mean Velocity AP-ML, Sway Path) were acquired using a pressure platform.
- The anthropometric variables (body mass, height and shoes size) were divided in nine anthropometric ranges respectively: body mass (under 80 kg), (80-90 kg), (90-100 kg); height (under 180 cm), (180-190 cm), (190-200 cm) and shoes size (40-42), (42-44) and (45-46).
- Shooting stability was analysed computing the mean and standard deviation of the six sessions of the eighteen subjects.
- Correlation analysis was run with Minitab software between the anthropometrics and posturoghraphic variables during the shooting.

a) b) c)

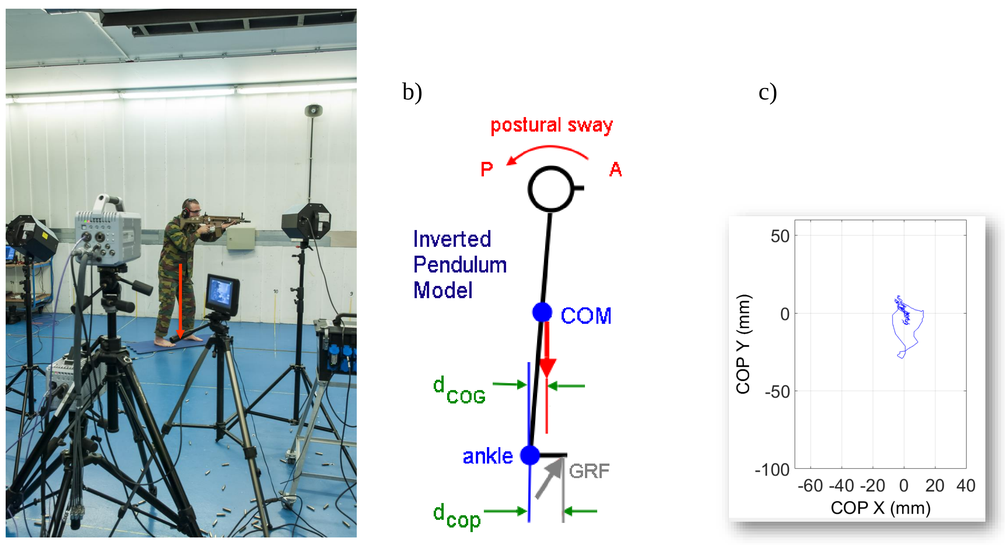



**Fig. 1**: (a)The setup (b) A reverse pendulum simple hinged at the ankle with a single degree of freedom on the sagittal plane (c) Statokinesiogramm (X,Y) during one single shot

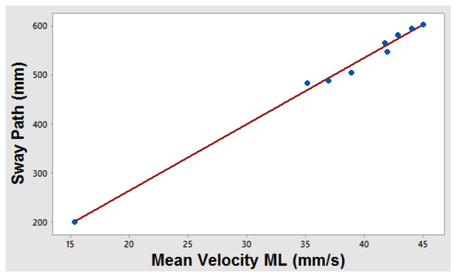
## Results and Discussion

The first analysis showed a strong correlation between the Sway Path and Mean Velocity AP-ML (r=0.9, p< .005).
This brings up the question if the correlation could be stronger between the anthropometric and postural control variables using anthropometric range categories.
The correlations between the Sway path and Mean Velocity AP (a) and ML (b) in the nine anthropometrics ranges revealed a strong significance with r=0.9 (p< .005).

| Sway Path in: | Vx | Vy |
|---|---|---|
| **Shoes size ranges( ranges EU)** | | |
| 40-42 | 0,9 | 0,9 |
| 45-46 | 0,9 | 0,9 |
| 43-44 | 0,9 | 0,9 |
| **Body mass ranges(kg)** | | |
| < 80 | 0,8 | 0,9 |
| 80-90 | 0,9 | 0,9 |
| 90-100 | 0,9 | 0,9 |
| **Height ranges(cm)** | | |
| <180 | 0,9 | 0,9 |
| 180-190 | 0,8 | 0,9 |
| 190-200 | 0,9 | 0,9 |

**Tab. 2**: Correlations value between the Sway path and Mean Velocity AP and ML in the nine anthropometric ranges

a)




b)

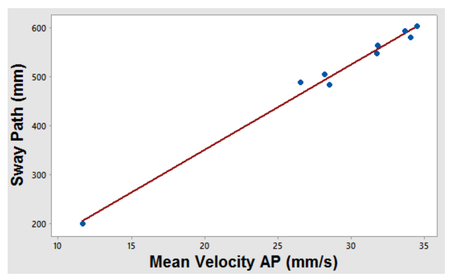



**Fig. 2:** Positive correlation between the Sway Path and Mean Velocity AP(a) and ML(b) in the nine anthropometric ranges categories.

| Shoes Size ranges (EU) | Sway Path (mm) | Vx_mean (mm/s) | Vy_mean (mm/s) |
|---|---|---|---|
| 40-42 | 593,03 | 33,64 | 44,04 |
| 45-46 | 198,32 | 11,61 | 15,27 |
| 43-44 | 504,08 | 28,13 | 38,86 |
| **Body Mass ranges(Kg)** | | | |
| <80 | 563,92 | 31,76 | 41,75 |
| 80-90 | 546,41 | 31,71 | 41,91 |
| 90-100 | 482,47 | 28,49 | 35,14 |
| **Height ranges (cm)** | | | |
| <180 | 487,63 | 26,485 | 36,91 |
| 180-190 | 580,37 | 34,026 | 42,81 |
| 190-200 | 602,10 | 34,47 | 45,01 |

**Tab. 3** Correlations value between the Sway path and Mean Velocity AP and ML in the nine anthropometric ranges

## Future perspective

Future perspective can be adress to evaluate the correlations between the postural variables and the 3D accelerations (X,Y,Z) detected from a Smart Shirt [8] worn by the 18 subjects during the same protocol.

**References**
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