Supplementary material to Barela AM, Stolf SF, Duarte M (2006) Biomechanical characteristics of adults walking in shallow water and on land. Journal of Electromyography and Kinesiology, 16, 250-256.

For walking in water, the following equation expresses the relation between the mechanical impulses due to the anterior-posterior (AP) ground reaction force (GRF_{AP}) and the AP water drag force (F_d) during the single support phase of the stride[1]:

$$\int_i^f (GRF_{AP})dt - \int_i^f (F_d)dt = m(v_f - v_i) \qquad (1)$$

Where m is the participant's mass, v_i e v_f are, respectively, the initial and final AP velocity at the single support phase. The first term on the left hand side of Eq.1 was computed as the integral of the GRF_{AP} versus time curve during the single support phase. The AP velocity was taken from the AP velocity of the trunk marker. At low speeds, the drag force, F_d, on the human body moving in water can be expressed by:

$$F_d = 0.5 \cdot \rho \cdot C_d \cdot A \cdot v^2 \qquad (2)$$

Where ρ is the water density (1000 kg/m^3); C_d is the drag coefficient of the human body in the upright position, considered here as 1.0; A is the frontal area of the human body in the upright position up to the Xiphsternum level, and v is the participant's average AP speed (estimated from the trunk marker) during the support phase. The frontal area of each subject up to the Xiphsternum level was estimated by

[1] The force plate measured only the ground reaction forces on the right leg. Because of that, only the period of single support phase of the right leg (equal to the total stance phase minus the double support phase) was used here. The single period of the support phase was estimated as the total support time minus half of the swing time. The single support phase during walking in shallow water lasted 0.95±0.03 s (40.1±1.4% of the stride duration) across participants.

measuring his or her frontal area in a digital photo calibrated to real dimensions in a procedure implemented in Matlab. This area ranged from 0.20 to 0.30 m^2 among participants. The mean values of the forces on the left side of Eq. 1 were calculated by diving each integral by the single support phase period. Figure 1 shows the mean GRF_{AP} (after subtracting $m(v_f - v_i)$ divided by the same period) versus the mean drag force for all trials of all participants. One can observe that the mean GRF_{AP} and the mean drag force were indeed correlated (r = 0.62, p<0.001) with the following linear equation fitted by least squares describing this relation: $GRF_{AP} = (4.3 \pm 3.2) + (0.79 \pm 0.11) \times F_d$, which is close to the identity (see Figure 1).

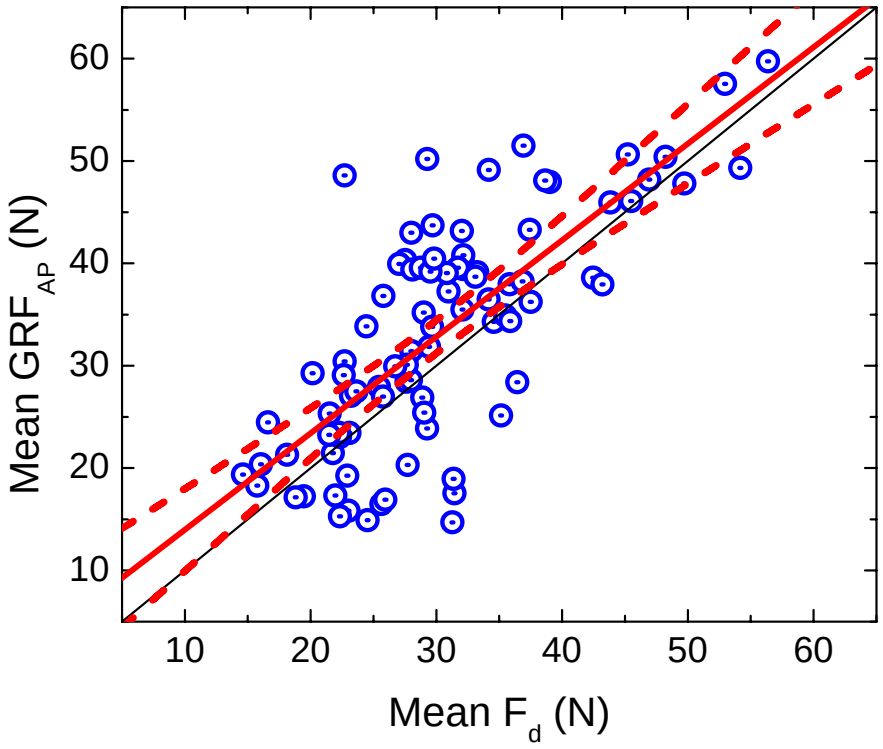

Figure 1. Mean anterior-posterior GRF (GRF_{AP}) versus the estimated mean drag force (F_d) during the stance phase of walking in water for all trials and 10 participants. The thick line represents the linear fit to the data, the dashed lines the 95% confidence band, and the thin line the identity.