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Interactive comment on "Hydrodynamics of pedestrians' instability in floodwaters" *by* Chiara Arrighi et al.

Chiara Arrighi et al.

chiara.arrighi@dicea.unifi.it

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On behalf of my co-authors I would like to thank the anonymous referee #2 for his comments and his interest in the manuscript. We absolutely agree with the referee on the first point concerning the scatter of existing experimental data. It is perfectly understandable why experiments carried out on different human subjects (i.e. children or professional stuntmen) differ in the corresponding pairs of water depth and velocity. We also stress these 'dimensional' differences in terms of estimated forces while commenting Fig.5 for instance. In the manuscript we are not arguing that the scatter is not physically meaningful, but, given the existing scatter, we investigate the hypothesis that a limited number of dimensionless parameters can explain most of the existing variability. In our opinion, the mobility parameter and the dimensional analysis are capable of identifying two main actors in the phenomenon of instability of pedestrians in

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Discussion paper

floodwaters, which are relative submergence and Froude number. The contribution of these parameters is then investigated through a 3D numerical model. The discussion on the numerical results also include the effect of other parameters, which were not investigated in this study, but are left for a future research. Regarding the use of the data by Abt et al. and by Takahashi, in the first case we considered the experimental conditions not fully representative of a 3D flow and limited in the investigated range of flow regimes, in the latter it was not possible to retrieve the heights of the tested subjects to calculate the mobility parameter. In order to better clarify these points we will add some new paragraphs in the final revised version.

It is true that we only considered one flow orientation as a simplifying assumption; also most of the existing experimental studies neglect the effect of the angle of flow incidence. We also considered a rigid body thus we neglect the walking condition. As replied to E. M. Gomariz, the boundary conditions and set up of the 3D numerical model should be completely modified to account for a non-rigid or moving body and this is out of the scope of the manuscript. We will add a further discussion to clarify this point.

The 3D model aims at investigating the role of the mean flow properties on the phenomenon of instability and a turbulence model was not selected for two main reasons: first, a turbulence model needs the calibration and/or validation of some coefficients and adequate experiments were not available for this purpose; second we are approximating with a rigid body the experimental conditions for subjects which were allowed to move freely. This obviously bears an error in the estimation of the forces on the subject, thus we considered our assumption adequate for the intrinsic uncertainties of the simulated problems. Moreover, as stated in the manuscript, the results of the simplified numerical model were acceptable for a circular cylinder used as a benchmark. The stability of the flow was checked and the parameters were extracted once the simulation reaches steady conditions. The time required for simulating 1 s was about 30 minutes with one core and important reductions of the computational time were achieved through parallelization. We will better clarify the reasons of our hypothesis and the other points in the manuscript.

Assuming the water density equal to the human density is quite common in the conceptual models since the density of floodwater is reasonably higher than freshwater density, due to suspended solid transport. From the physical point of view, this assumption means that in fully submerged conditions the human body lies in static equilibrium. About the lift force orientation we will add a clearer explanation in the text, however the lift force is oriented downward as long as the only horizontal surface involved in the flow is that of the feet, it becomes upward-oriented when the lower part of the body trunk is reached by the flow. The interpretation of the variation of drag and lift coefficients will be clarified highlighting in the diagrams (Fig. 4) how the force coefficients were initially defined. This should resolve the ambiguity of the variation of the forces and force coefficients with the submergence and help in the overall understanding of the manuscript.

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