SUPPLEMENTARY MATERIAL

Spatial normalization of time series data

To compare time series data for speed, E_{KIN}, F_{GRF}, F_F and $Coeff_F$, parameters were not time normalized from start to end of turns (which is usual for analysis in slalom and giant slalom,[1-3] but causes a certain bias between fast and slow skiers when the analysed sections are long, as it is typical for super-G and downhill); instead they were expressed as the distance from start to the instantaneous position of the skier along the course. Based on all measured skier trajectories and a geometrical approach,[4] an average trajectory was calculated from start to finish line. Each 0.3m along the average trajectory, a virtual plane was spanned normal to the average trajectory and was intersected with each of the single trajectories.[5] At each intersection point, the corresponding time series values for speed, E_{KIN}, F_{GRF}, F_F and $Coeff_F$ were interpolated and stored as a function of the distance from start along the average trajectory to the instantaneous position on the race track. This approach removes any bias of time shift in the time series data and allows comparing the parameters at the corresponding locations. In the figures, instantaneous parameter mean and standard error were plotted in function of distance from start. Distance from start was indicated with gate passage locations.

REFERENCES

1.   Supej M, Kugovnik O, Nemec B. Kinematic determination of the beginning of a ski turn. *Kinesiologia Slovenica*. 2003;9(1):11-7.

2.   Spörri J, Kröll J, Schwameder H, et al. Turn characteristics of a top world class athlete in giant slalom – a case study assessing current performance prediction concepts. *Int J Sport Sci Coach*. 2012;7(4):647-59. doi:10.1260/1747-9541.7.4.647.

3.   Spörri J, Kröll J, Schwameder H, et al. Course setting and selected biomechanical variables related to injury risk in alpine ski racing: an explorative case study. *Br J Sports Med.* 2012;46(15):1072-7. doi:10.1136/bjsports-2012-091425.

4.   Gilgien M, Haugen P, Reid R. Comparison of mechanical injury risk factors between male and female World Cup Alpine Skiers in the discipline Super-G. In: Book of Abstracts of the 20th Annual Congress of the European College of Sport Science (ECSS); Malmö, Sweden2015.

5.   Supej M, Holmberg HC. A New Time Measurement Method Using a High-End Global Navigation Satellite System to Analyze Alpine Skiing. *Research Quarterly for Exercise and Sport.* 2011;82(3):400-11.