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Comment on *A Model of Wind and Altitude Effects on 110-m Hurdles*

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In their article, Spiegel and Mureika have presented a model of the men's 110-m hurdles that gives good agreement between predicted and actual race times and velocity profiles. However, using such a model to predict the effects of wind and altitude is slightly problematic in that these effects are small, so small discrepancies in the model lead to inaccurate predictions. Previous experiences with models of wind assistance suggest that a good result for a model is to predict the effects of wind and altitude to within a factor of about 2 of the true effects (Ward-Smith, 1985, 1999; Linthorne, 1994). Better predictive ability will require some good direct experimental results of the effect of wind and altitude on the 110-m hurdles to allow fine tuning of the model. The authors' model appears to be well reasoned, but will almost certainly require fine tuning at a later stage to give agreement with experimental results.

The magnitude of the effect of wind and altitude predicted by Spiegel and Mureika's model appears to be too great. The predicted effect of a +2.0 m.s^{-1} wind on the 110-m hurdles is 0.19 s. The effect of a +2.0 m.s^{-1} wind on the 100-m sprint is 0.10 s (Linthorne, 1994), and one would expect a similar effect in the 110-m hurdles, as explained below. The authors acknowledge that their results are surprising, and this should have triggered an investigation as to why their predictions are "out".

The hurdle clearance stride is not likely to be a significant source of extra time from wind and altitude effects. In a 100-m sprint the athlete usually takes about 45 strides (= 0.45 strides per meter), and in the 110-m hurdles the athlete has a similar number of strides per distance (8 start strides + 9×3 in-between strides + 10 clearance strides + 6 run-in strides = 51 strides, which is equivalent to 0.46 strides per meter). The authors take into account the hurdle clearance stride where there is only the aerodynamic force acting on the athlete, but the extra distance of the hurdle clearance stride is only 0.5 m, and during this time the athlete *reduces* frontal area. The effect of the clearance stride is therefore expected to be negligible or to even *reduce* the effect of wind on the total race time (compared to the 100-m sprint).

In the hurdles race the athletes run at a slower speed (9.0 m.s^{-1} vs 11.5 m.s^{-1}), which will reduce the effect of wind on the race time, but the athletes run for a longer duration (13 s vs 10 s), which will increase the effect of wind. These two effects will come close to canceling each other, with possibly the slower speed dominating because of the v^2 form of wind assistance. Overall you would expect the predicted effect of a +2.0 m.s^{-1} wind in the 110-m hurdles to be almost the same as in the 100-m sprint; about 0.10 s.

The best argument that the author's predicted effects of wind and altitude are overestimates lies with the calculated top-ten finishes (their Table 4). The list has a strong bias towards negative wind readings, when you would expect a random distribution of wind readings. The order of wind readings in Table 4 is -1.6, -0.1, -0.2, -0.5, 0.0, 0.2, 0.5, 0.6, 0.9, 1.6, and 1.5. Also, you would expect one or two performances from the non-legal list (Table 3) to make the top-ten finishes list, but none do, and most come nowhere near making the list. The results presented in Table 4 should have sent the alarm bells ringing and triggered a re-examination of the model, the assumptions of the model, and the parameter values used in the simulations.

In the first version of the manuscript, the authors did not adequately reference the work of Ward-Smith. He developed a mathematical model of the effect of the wind on 100-m sprint times (Ward-Smith, 1985), and he extended this model to calculate the effect of wind on the 110-m hurdles (Ward-Smith, 1997). The model includes the energy required to raise the center of mass up over the hurdle (about 30 cm). This aspect of the event was not included in Spiegel and Mureika's model. Ward-Smith predicted that a +2.0 $m.s^{-1}$ wind reduces a 110-m hurdle race time by 0.24 s. However, this result was obtained using an old version of his wind effects model. He recently revised his 100-m wind effects model (Ward-Smith, 1999) to bring the predicted effect of a +2.0 $m.s^{-1}$ wind into line with the experimental results of Linthorne (1994). Applying a similar correction (0.18 s with the old 100-m model; 0.10 s with the revised 100-m model) to his 110-m hurdles result gives a revised prediction of 0.13 s. This revised prediction is likely to be closer to the true wind effects value than the 0.19 s predicted by Spiegel and Mureika.

References

Ward-Smith AJ (1985). A mathematical analysis of the influence of adverse and favourable winds on sprinting. Journal of Biomechanics 18, 351-357

Ward-Smith, AJ (1997). A mathematical analysis of the bioenergetics of hurdling, Journal of Sports Sciences 15, 517-526

Ward-Smith, AJ (1999). New insights into the effect of wind assistance on sprinting performance, Journal of Sports Sciences 17, 325-334

Linthorne NP (1994). The effect of wind on 100-m sprint times. Journal of Applied Biomechanics 10, 110-131

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