MODELING PERFORMANCE TRAJECTORIES OF ELITE ATHLETES IN WORLD CUP RACES OVER AN OLYMPIC QUADRENNIUM

Bullock Nicola1, Hopkins Will G.2, Martin David T.3, Marino Frank E.4
(Australian Institute of Sport/Charles Sturt University1, Australia, AUT University2, New Zealand, Australian Institute of Sport3, Australia, Charles Sturt University4, Australia)

In many sports, variation in performance time between races arising from differences and changes in venues and weather far exceeds differences and changes in the athletes' true ability. Currently, coaches can track the progression of athletes in such sports only using race placings. We present here a new method using race times. METHODS: We used linear mixed modeling to track progression of each athlete's race times. Fixed and random effects in the model were used to adjust for and estimate variability in race times arising from differences and changes in venues, weather, and athletes. An additional fixed effect estimated the advantage athletes experienced at their home venue. A key feature of the model was inclusion of random effects to estimate quadratic trajectories for each individual's race time as a percent of the mean race time that would be observed at an average venue under average weather conditions. We tested this model using the winter sliding sport known as skeleton. Times in World Cup races over the last Winter-Olympic quadrennium were collected from the official FIBT Internet database. Only athletes who placed in the top 20 and competed in at least three races were included for analysis. The residual variance in the mixed model was therefore the athletes' run-to-run variability, and we modeled a different variance for each track. We compared the times predicted by each athlete's trajectory with observed race times by deriving the correlation between predicted and observed times at each venue and averaging them. To replicate the way coaches currently track athletes' progression, we derived trajectories based on fitting quadratic curves to each athlete's race placing using simple polynomial regression. We also repeated these analyses using transformed placings to account for normal and skewed distributions of race times. We then compared the correlations between predicted placings and observed times with the correlations for the new method. RESULTS: The final dataset consisted of 33 men competing in 23 races at 11 venues, and 34 women competing in 25 races at the same 11 venues. Differences in run-to-run variability of the venues (0.24-0.59% for men, 0.34-0.71% for women) paralleled differences in popular opinion of technical difficulty of the venues. The home advantage was 0.42% for men and 0.54% for women. The correlations between race times and times predicted by the new method were 0.96 ± 0.04 for men and 0.94 ± 0.07 for women (mean ± SD); corresponding correlations for the methods based on placings ranged from 0.71 ± 0.15 to 0.78 ± 0.13. CONCLUSION: Mixed modeling of race times in skeleton provides performance trajectories for individual athletes that are superior to predictions based on race placings. This new modeling approach is robust and could be used with any sports where venue and weather have substantial effects on race time.

Keywords: Sport Performance, Modeling, Elite Sport

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