Differences in sprinting force-velocity-power profiles between sports according to maturity status

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Résumé

Introduction: The ability to produce maximal power (Pmax) during sprint acceleration is a key determinant of physical performance. For a given Pmax, an athlete may lack the ability to apply force at low velocities ($F0$) or at high velocities ($v0$). Recent research has indicated the existence of an optimal force-velocity profile (the force-velocity slope, SFV) for a given Pmax highly dependent on sprint distance, with performance for shorter distances increasingly reliant on $F0$, and performance for longer distances increasingly reliant on $v0$ (1). Average sprint distance covered in competition varies across sports disciplines, likely due to differences in pitch dimensions, number of players, specific performance and the rules of the game. These differences in sporting practices can lead to variations in force-velocity-power (F-v-P) profiles of the athletes from one discipline to another. In youth, growth and maturation affect F-v-P profiles via changes in body dimensions and neuromuscular adaptations (2). Then, the present study aimed to compare the F-v-P profiles of young athletes at different maturity statuses across four sprint-based sports (athletics, football, rugby, and handball).
Methods: A total of 120 youth athletes (30 per sport) participated in this study (age range: 12.0–16.9 years). Participants were matched for chronological age (±0.5 year) and maturity offset (MO) (±0.5 year). All athletes trained 2 to 5 times a week. Each participant completed an experimental session that included anthropometric measurements (standing height,

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sitting height, body mass) and an assessment of the sprint acceleration F-v-P profile. MO, expressed in years from peak height velocity, was estimated using the Mirwald equation (3). For the sprint F-v-P profile, raw speed-time data for two maximal 30-meter sprints (standing start) were measured with a radar (Stalker ATS II, 46,875 Hz), and sprint performance was captured with photocells at 10 and 30 meters. Samozino's method (4) was applied to obtain $F0$ (N.kg-1), $v0$ (m.s-1), Pmax (W.kg-1) and SFV (N/kg.s/m). An analysis of covariance was performed to examine whether the type of sport significantly affected F-v-P and sprint performance variables, while statistically controlling for MO. Analyses were conducted using RStudio (v1.4.1106), with significance set at $p < 0.05$.

Results: Sport had a significant main effect on all variables except absolute Pmax, and MO showed significant effects on all variables. Post-hoc analyses showed that all sports had significantly higher relative Pmax (W.kg$^{\mathbf{1}}$) than rugby ($p < 0.01$), with no differences among the other sports. Handball and athletics displayed higher relative $F0$ (N.kg$^{\mathbf{1}}$) than rugby ($p < 0.02$), while football did not differ. Football had significantly higher $v0$ than handball and rugby ($p < 0.01$), with no difference from athletics. Handball had the most force-oriented F-v profile, differing from football and rugby ($p < 0.01$). For sprint times, football and rugby outperformed handball and athletics at 10 m ($p < 0.001$), and football was the fastest at 30 m ($p < 0.001$). Finally, when comparing slopes between sports, only football showed a lower decrease with MO than all other sports for the 10-m sprint time ($p < 0.05$ to $p < 0.01$) and lower than rugby and handball for the 30-m sprint time ($p < 0.05$).

Discussion & Conclusion: Among youth athletes, most disciplines showed similar sprint F-v-P profiles, except rugby, which exhibited significantly lower relative Pmax and $F0$, likely due to higher body mass reducing mass-specific power and force. Overall, sports involving longer sprint distances (*e.g.,* athletics and football) exhibited more velocity-oriented profiles than those emphasising shorter accelerations (*e.g.,* handball). When the F-v-P parameters are adjusted for MO, no significant differences are observed between sports. This suggests that MO exerts a predominant influence on these specific motor skills in youth. Nevertheless, improvements in sprint performance varied across disciplines, with football showing a smaller progression with MO compared to other sports. This may be due to the relatively high initial training level of footballers and their early recruitment into competitive environments, which limits the potential for further improvement.

References:

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