

Doctoral thesis abstract

Maximising Power Across the Range of Sprint Velocities: An Individualised Approach to Assisted Sprint Training

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ABSTRACT

1. BACKGROUND

Sprint performance depends on the capacity to produce and apply force effectively across a wide range of running velocities (Morin et al., 2012). Force-velocity profiling can identify whether an athlete is relatively force- or velocity-oriented and may therefore help guide individualised training (Lahti et al., 2020). Assisted sprint training targets the velocity end of this spectrum by exposing athletes to supramaximal running speeds, but its implementation is limited by uncertainty regarding measurement accuracy, neuromuscular responses to different towing strategies, transfer to unassisted sprinting, and large inter-individual variability. The dissertation aimed to investigate how individualised assisted sprint strategies, delivered by a validated motorised towing device, can be used to maximise sprint power across running velocities. The objectives were to: (1) Establish the validity and reliability of the Alex7 motorised device during resisted and assisted sprinting; (2) Compare the acute neuromuscular, spatiotemporal, and kinematic responses to full and partial towing assistance; and (3) Evaluate the effects of a six-week assisted sprint intervention on sprint performance, spatiotemporal variables, and force-velocity profiles, while examining whether baseline mechanical characteristics were associated with individual responsiveness.

2. METHODS

The dissertation comprised three interconnected studies conducted on an indoor 60-m track. Study 1 used a repeated-measures design with 27 male youth football players (age 16.5 ± 0.8 years) to assess the validity and reliability of Alex7 during 30-m resisted sprints (10% body mass) and assisted sprints (constant 6 kg towing force). Alex7 split times were compared with Witty timing gates, and test-retest reliability was evaluated across two sessions. Study 2 included 13 male athletes (age 21.4 ± 1.5 years) who completed unassisted, fully assisted (continuous 6 kg towing force), and partially assisted 30-m sprints; in the partial condition, assistance was released when velocity reached $0.5 \text{ m}\cdot\text{s}^{-1}$ below the individual supramaximal speed. Surface electromyography was recorded from the Gluteus Maximus, Rectus Femoris, Vastus Lateralis, Semitendinosus, and Biceps Femoris, while inertial sensors and OptoJump quantified lower-limb kinematics and spatiotemporal characteristics. Study 3 was a six-week controlled intervention in male youth football players (final $N = 24$). Athletes were allocated to fully assisted ($n = 9$), partially assisted ($n = 8$), or control ($n = 7$) groups. The training groups completed 12 sessions (two per week), each comprising four maximal 30-m assisted sprints with five minutes of recovery. Regular and assisted 30-m sprints were assessed before and after training. Horizontal force-velocity profiles were derived from corrected split times using the Samozino field



method (Samozino et al., 2016) and a temporal-off-set correction (Stenroth et al., 2023). Individual responses were interpreted using a minimal detectable change of 0.13 s; high responders improved by at least 0.19 s, whereas non-responders improved by no more than 0.13 s.

3. RESULTS

In Study 1, Alex7 sprint times showed good-to-excellent test-retest reliability in resisted and assisted conditions (intraclass correlation coefficients 0.83–0.94; coefficients of variation 0.80–1.43%). Associations with Witty timing gates were very large to nearly perfect ($r = 0.88$ – 0.98); however, Alex7 generally recorded longer times, with differences of up to 0.16 s, indicating that it is suitable for consistent training monitoring but should not be used interchangeably with timing gates (Skujytė et al., 2024). In Study 2, both assisted conditions reduced 30-m sprint time compared with unassisted sprinting (full: -2.8% , $p < 0.01$; partial: -3.4% , $p < 0.001$). The faster performances were accompanied by longer stride length ($+8.6\%$ and $+8.9\%$), longer flight time ($+7.7\%$ and $+7.8\%$), and shorter contact time (-4.9% and -6.9% for full and partial assistance, respectively), with no change in stride frequency or hip and knee joint angles. Mean activation of all five muscles did not differ significantly among conditions. Nevertheless, effect-size analysis revealed brief, muscle-specific differences at discrete gait-cycle phases, particularly around late swing and the transition to stance; these findings were limited by high inter-individual variability (Skujytė, Kamandulis et al., 2026). In Study 3, the fully and partially assisted protocols produced no meaningful differences in performance or spatio-temporal outcomes and were therefore combined for comparison with the control group. Assisted 30-m performance improved in the intervention group from 4.24 ± 0.15 to 4.10 ± 0.19 s, whereas the control group remained unchanged (group $\times$ time interaction: $p = 0.01$, partial $\eta^2 = 0.26$). Transfer to regular 30-m sprinting and most spatiotemporal variables was limited. Responses were heterogeneous: high responders improved assisted sprint time by 0.23 ± 0.03 s, compared with 0.04 ± 0.08 s in non-responders ($p < 0.001$, $d = 3.07$). High responders had greater baseline theoretical maximal force ($p = 0.01$, $d = 1.65$), maximal power ($p = 0.01$, $d = 1.80$), and maximal ratio of force ($p < 0.01$, $d = 1.87$). Baseline maximal power and maximal ratio of force derived from regular sprinting were the

strongest predictors of assisted sprint improvement (adjusted $R^2 = 0.63$ and 0.54 , respectively) (Skujytė, Šilinskas et al., 2026).

4. CONCLUSIONS

Alex7 provides valid and reliable measurements for monitoring resisted and assisted sprinting during training. Full and partial towing assistance produce comparable acute responses: both increase sprint velocity primarily through longer strides and shorter ground contact, without reducing mean lower-limb muscle activation or materially altering hip and knee kinematics. Six weeks of assisted sprint training improves performance under assisted conditions, but transfer to unassisted sprinting is limited over this timeframe. Adaptation is highly individual and is related to baseline force-velocity characteristics, particularly force-production and power capacities. These findings support the use of controlled motorised assistance as a specific supramaximal training stimulus and indicate that force-velocity profiling may help identify athletes most likely to benefit. Assisted sprinting should be progressively dosed and integrated with high-quality unassisted sprinting when transfer to regular sprint performance is the primary objective.

Keywords: Assisted sprint training, force-velocity profile, Alex7, sprint biomechanics, supramaximal velocity

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