Training Load-Mediated Speed and Agility Gains in Wing Players: A Comparative Study of Circuit and Velocity-Based Resistance Protocols in Collegiate Handball

Syed Anwar Ali S1\*, Kalaivani S2

1*Manipal Academy of Higher Education, Manipal, Karnataka, India 1*

2*Manipal Academy of Higher Education, Manipal, Karnataka, India 2*

\*syed.s@manipal.edu

**Abstract**

Sprint and agility performance are the critical factors for handball wing players, who perform rapid accelerations, decelerations, and multidirectional movements during competitions. While resistance training has been reported to improve these performance parameters, its relative efficacy with respect to training modalities remains unexplored in a position-specific context. The present study investigated the relative effect of VBT versus CT on sprinting and agility performance of collegiate male handball wing players with a non-training control group considered for natural variations. A six-week single-blinded randomized controlled trial was implemented with 19 players stratified by the baseline sprint performance and randomly assigned to VBT (n = 6), CT (n = 7), and CON (n = 6). All groups continued specific training for handball exercises, with VBT and CT groups afforded the paradigm and extra resistance protocols. The 40-m sprint and Illinois Agility tests were run as pre- and post-tests to record changes. Load internal training was recorded via session-RPE. The results warned of a stark performance hierarchy: VBT > CT > CON. The VBT group registered the highest improvements in sprint time (-0.21 s) and agility (-0.38 s), statistically higher than both CT and CON. These improvements emerge because of the neuromechanical specificity of VBT and emphasis on concentric velocity and autoregulated loading prescription. This represents among the primary controlled comparisons of VBT and CT under a handball-specific context, providing evidence as to how to optimize in-season conditioning for speed-dominant positions. This finding bodes well for the use of VBT as a strategic solution to improving explosive movement abilities in competitive wing players.

**Keywords:** Agility, Athletic Performance, Handball, Resistance Training, Sprinting

**Introduction**

Describing any fine-grained positional variance leads one to accept the assertion that wing players require more sprint development and agility in carrying out fast breaks, lateral cuts, and very fast directional changes on the side. The latter must entail anaerobic power and coordination with rapid neuromuscular activation (Granados et al., 2007; Póvoas et al., 2012).

Technical-tactical training will result in skill execution; yet, special physical preparation should be followed to develop explosive attributes such as sprinting and agility. The best resistance training adapts for increased rate of force development (RFD) and motor unit recruitment. Circuit training (CT) is general conditioning for team sports, with no velocity specificity for performance improvements at high speed (Wilmore & Costill, 2004). Contrastingly, with Velocity-Based Training (VBT), speed of movement is prioritized and emphasized at submaximal loads facilitating neuromechanical adaptations that comply with high-intensity actions in sport (González-Badillo & Sánchez-Medina, 2010).

The growing interest in VBT has set apart plenty of research to compare this method with the traditional ones in resistance training for handball players. There continues to be some scarcity of position-specific evidence, especially for wing athletes. This study seeks to fill this gap by evaluating the effectiveness of VBT and CT, with a control group for baseline comparison, on sprint and agility of male competitive collegiate handball wing players.

**2. Methods**

**2.1 Research Design**

The six-week interventional procedure that was single-blinded RCTs with pre- and post-parallel-group testing design. Participants were stratified on baseline sprint performance and randomly assigned to any of the three groups: Velocity-Based Training (VBT), Circuit Training (CT), and Control (CON). Sprint and agility performance assessments were done prior to and following intervention.

**2.2 Participants and Procedures**

Nineteen male college-age individuals between 18 and 25 years practiced handball at the wing position. Inclusion criteria were that subject must be currently practicing with the handball team on any regular basis and never have followed a VBT program. The exclusion criteria were set to account for lower-limb injuries in the past six weeks, any concurrent strength training program, and failures in compliance with the study. During the program duration, the participants generally kept their conventional handball training, while only the VBT and CT subgroups undertook three weekly sessions of supplementary resistance training over six weeks.

**2.3 Instruments and Materials**

Sprint performance was determined using a 40-m linear sprint test, and the agility tests used was the Illinois Agility Test. Tests had their results electronically recorded with timing gates to the nearest 0.01 s. Internal training load was calculated according to the session-RPE method (RPE × duration of the session in minutes), and data were collected 30 minutes after the end of the training session.

**2.4 Data Analysis**

The analyses were performed in SPSS v26.0. Normality checks were done using the Shapiro–Wilk test. A 2 × 3 (Time × Group) repeated-measures ANOVA assessed changes in performance, with Bonferroni-corrected post hoc comparisons and effect size reported as partial eta squared (η²). Results were considered statistically significant when p < .05.

**3. Results and Discussion**

Intervention completion saw the three groups with very high adherence rates (VBT: 98%; CT: 96%). Internal training load, calculated based on session-RPE, indicated a comparable perceived exertion between the VBT and CT groups, although the training mechanisms themselves were different.

**Table 1.** Sprint and Agility Performance Outcomes and ANOVA Results

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Group** | **Sprint Pre (s)** | **Sprint Post (s)** | **Δ Sprint (s)** | **Agility Pre (s)** | **Agility Post (s)** | **Δ Agility** **(s)** | **ANOVA F / p (Sprint, Agility)** |
| **VBT** | 5.63 ± 0.11 | 5.42 ± 0.09 | -0.21 ± 0.04 | 17.13 ± 0.31 | 16.75 ± 0.27 | -0.38 ± 0.06 | 9.82 / <.01 |
| **CT** | 5.67 ± 0.10 | 5.56 ± 0.08 | -0.11 ± 0.03 | 17.28 ± 0.28 | 17.07 ± 0.26 | -0.21 ± 0.05 | - |
| **CON** | 5.64 ± 0.09 | 5.63 ± 0.10 | -0.01 ± 0.02 | 17.19 ± 0.33 | 17.17 ± 0.31 | -0.02 ± 0.04 | - |

The six-week intervention saw the VBT group display the greatest improvements in sprint and agility. Sprint time dropped from 5.63 ± 0.11 s to 5.42 ± 0.09 s (Δ = -0.21 ± 0.04 s), while agility time improved from 17.13 ± 0.31 s to 16.75 ± 0.27 s (Δ = -0.38 ± 0.06 s). The changes were statistically significant (ANOVA F = 9.82, p < .01) and thus followed the largest improvements in performance among the three groups. The CT group also displayed some meaningful, though less so, improvements: a sprint time decrease of 0.11 ± 0.03 s and an agility increase of 0.21 ± 0.05 s. The CON group, conversely, remained unchanged in sprint (-0.01 ± 0.02 s) and agility (-0.02 ± 0.04 s) time, implying that the improvements seen in the VBT and CT groups were due to the intervention rather than regular training.

**Figure 1.** Sprint and Agility Change Scores by Training Group (VBT, CT, CON) with ANOVA Summary

As Figure 1 shows, Velocity-Based Training (VBT) witnessed maximal change in sprint (-0.21 s) and agility (-0.38 s), compared with CT and CON. The significant group × time interaction (F = 9.82, p < .01) indicates that VBT with its velocity-based stimuli imparts better neuromuscular adaptations to high-speed tasks in handball.

**Table 2.** Internal Training Load Metrics

|  |  |  |  |
| --- | --- | --- | --- |
| **Group** | **Avg. RPE** | **Total Load (AU)** | **Weekly Avg (AU)** |
| **VBT** | 6.6 ± 0.4 | 1320 ± 87 | 220 ± 15 |
| **CT** | 6.8 ± 0.5 | 1355 ± 92 | 226 ± 17 |

The training loads of the participants of the two groups, VBT, and CT, were similar. Loading in the VBT group: Total of 1320 ± 87 AU, with participants, rating RPE 6.6 ± 0.4. Loading in the CT group: Total of 1355 ± 92 AU, with participant's ratings being higher at RPE 6.8 ± 0.5. Average weekly loads were also almost the same, 220 ± 15 AU for VBT and 226 ± 17 AU for CT, which further makes sure that differences in performances were not due to differences in training volume or perceived exertion. The purpose of this study was to investigate the influence of Velocity-Based Training (VBT) and Circuit Training (CT) on agility and sprint performance in competitive male handball wing players using a control group (CON) as a baseline. The findings confirm the hypothesis with VBT yielding significant superiority over CT and CON in terms of sprint and agility performance gains than CT and CON, respectively, despite both CT and VBT being performed under conditions of equal training load. Thus, the observed order of performance levels VBT > CT > CON highlights the critical role that neuromechanical specificity plays in resistance training interventions. The higher VBT group performances stemmed probably because of the priority set for maximal concentric movement velocity, which enhances rate of force development (RFD), motor unit recruitment, and the activation of Type II fibers all necessary for rapid multidirectional athletic movements. Supportive of this are moderate improvements after CT, but a lack of such velocity emphasis in its programs would not have optimized sprint and agility gains. Slight changes within the CON group imply that such improvements were not to allow for handball practice or natural variability. The dramatic differences in training loads between VBT and CT were minimized, thereby eliminating session duration or exertion as confounding factors in this regard leading to further support for a velocity-stimulus quality of VBT surpassing mere workload results in enhanced performance outcomes.

It is worth emphasizing that these findings justify using VBT protocols in handball conditioning throughout the season, particularly with wing players, who sprint in short bouts and make acute directional changes. This imparts a practical and very focused intervention not to overload the athletes during the congested competition periods, given the short session durations (45 minutes) and autoregulatory characteristics of VBT.

**4. Conclusions**

The study proved that velocity-based resistance training improves sprint and agility performance in collegiate male handball wing players much more than standard circuit training or regular team practice. The better results of the VBT group have been attributed to neuromechanical specificity, velocity emphasis, and its autoregulatory structure. These results suggest including VBT into the in-season conditioning programs, especially for roles that demand a lot of speed, like wing players. Coaches and practitioners may implement VBT protocols to help develop performance enhancements that are very specific while avoiding interference with normal training loads.

**Acknowledgment**

The authors express their sincere gratitude to the participating Players and coaches for their commitment and cooperation throughout the study. No external funding was received for this study.

**References**

Banyard, H. G., Nosaka, K., Haff, G. G., & Tran, T. T. (2019). The reliability of individualized load–velocity profiles. *International Journal of Sports Physiology and Performance*, *14*(7), 1005–1010. <https://doi.org/10.1123/ijspp.2018-0650>

Cormie, P., McGuigan, M. R., & Newton, R. U. (2011). Developing maximal neuromuscular power: Part 2 Training considerations for improving maximal power production. *Sports Medicine*, *41*(2), 125–146. <https://doi.org/10.2165/11538500-000000000-00000>

Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2009). Youth resistance training: Updated position statement paper from the National Strength and Conditioning Association. *Journal of Strength and Conditioning Research*, *23*(5), S60–S79. <https://doi.org/10.1519/JSC.0b013e31819df407>

González-Badillo, J. J., & Sánchez-Medina, L. (2010). Movement velocity as a measure of loading intensity in resistance training. *International Journal of Sports Medicine*, *31*(5), 347–352. <https://doi.org/10.1055/s-0030-1248333>

Granados, C., Izquierdo, M., Ibáñez, J., Ruesta, M., & Gorostiaga, E. M. (2007). Effects of an entire season on physical fitness in elite female handball players. *Medicine & Science in Sports & Exercise*, *39*(7), 1170–1178. <https://doi.org/10.1249/mss.0b013e31804c58ad>

Pareja-Blanco, F., Rodríguez-Rosell, D., Sánchez-Medina, L., Sanchis-Moysi, J., Dorado, C., & González-Badillo, J. J. (2017). Effects of velocity loss during resistance training on athletic performance, strength gains and muscle adaptations. *Scandinavian Journal of Medicine & Science in Sports*, *27*(7), 724–735. <https://doi.org/10.1111/sms.12678>

Póvoas, S. C. A., Ascensão, A. A., Magalhães, J., Seabra, A. F. T., Krustrup, P., & Rebelo, A. N. (2012). Physiological demands of elite team handball with special reference to playing position. *Journal of Strength and Conditioning Research*, *26*(12), 3365–3375. <https://doi.org/10.1519/JSC.0b013e3182474269>

Weakley, J. J. S., Mann, B., Banyard, H. G., McLaren, S. J., Scott, T., Garcia-Ramos, A., & Lumley, N. (2021). Velocity-based training: From theory to application. *Strength & Conditioning Journal*, *43*(2), 31–49. <https://doi.org/10.1519/SSC.0000000000000560>

Wilmore, J. H., & Costill, D. L. (2004). *Physiology of sport and exercise* (3rd ed.). Human Kinetics.