World Journal of Advanced Research and Reviews

eISSN: 2581-9615 CODEN (USA): WJARAI

Cross Ref DOI: 10.30574/wjarr

Journal homepage: https://wjarr.com/

(Review Article)

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Adaptive model for preparing a world-class sprinter: A phase-based approach, neuromotor adaptation and autoregulation

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World Journal of Advanced Research and Reviews, 2025, 28(02), 1591–1598

Publication history: Received on 08 October 2025; revised on 17 November 2025; accepted on 19 November 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.28.2.3874

Abstract

The article provides a scientific rationale for the adaptive training model for world-class sprinters 9.9X, conceptualized based on the author's elite-level competitive experience and an analysis of contemporary preparation systems. The relevance of the study is defined by the fact that traditional rigidly deterministic training schemes demonstrate limited efficacy in accommodating individual variability, often provoking overtraining and non-linear deteriorations in form. The novelty lies in integrating a phase architecture of preparation with weekly autoregulation and the introduction of targeted stressors–adaptive dynamic triggers (ADT)–that titrate the load in accordance with the athlete's current capacities. The model comprises four sequentially organized phases–from foundational formation of functional prerequisites to peaking–and rests on principles of autoregulation based on a combination of objective and subjective feedback indicators. Special emphasis is placed on neuromotor adaptation, Local Isolated Stabilization (LIS), and special strength preparation (SSP) as mechanisms that ensure technical robustness and the economy of speed–strength work. The aim of the study is to demonstrate that the adaptive logic of the 9.9X model represents a functionally superior alternative to classical periodization; to this end, methods of comparative analysis and synthesis of contemporary scientific literature are employed. In conclusion, it is shown that the 9.9X model ensures steady, sustainable progress while simultaneously reducing the likelihood of injury. The findings presented will be of interest to coaches, other researchers, and athletes focused on optimizing the training process.

Keywords: Sprinter Training; Adaptive Model; Autoregulation; Periodization; Neuromotor Adaptation; Elite Athletes; Performance Optimization; Adaptive Dynamic Trigger (ADT); Phase-Based Preparation; Sporting Results

1. Introduction

For decades, the preparation of elite sprinters has been shaped by polar methodological traditions. Soviet practices relied on high volumes and rigid calendar regulation, often at the cost of overloading the central nervous system. In turn, the American school was grounded in the primacy of maximal intensity and technical refinement, periodically underestimating the fundamental aerobic–anaerobic base. Modern integrative platforms such as ALTIS have advanced practice, yet they too often remain within comparatively fixed macrocycles. Such rigidity poorly accommodates the diurnal fluctuations of an athlete's psychophysiological status, increasing the risk of nonfunctional overreaching, injury, and untimely degradation of peak form. The pronounced interindividual variability of training responses, consistently demonstrated in the literature, indicates the need to transition to dynamic, athlete-oriented models [1, 4].

The study aims to substantiate the 9.9X system as an integrated adaptive model for training world-class sprinters and to demonstrate its superiority over traditional training paradigms.

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1.1. To achieve this objective, the following tasks were formulated

- Perform an analysis of historical and contemporary sprint training systems, identifying key limitations, primarily in terms of flexibility and individualization.
- Describe the architecture of the 9.9X model: its four-phase periodization, the logic of sequential transfer of adaptations, and the mechanism of the adaptive dynamic trigger (ADT).
- Substantiate the inclusion of autoregulation, neuromotor adaptation, local isolated stabilization (LIS), and special strength preparation as fundamental determinants of performance enhancement and long-term athletic resilience.

The scientific novelty lies in the fact that the innovative potential of 9.9X is achieved through the synthesis of a strictly structured phase progression with highly adaptive management within the macrocycle. Unlike models that rely on periodic shock weeks, 9.9X employs the ADT principle to purposefully construct controlled weekly micro-peaks in performance.

The working hypothesis is that systematic application of the adaptive 9.9X model, combining phase planning with real-time autoregulation and targeted neuromotor/structural development, ensures more stable and accelerated performance gains, reduces injury incidence, and increases the precision of peaking for key competitions compared with less adaptive traditional training systems.

2. Materials and Methods

A comparative analysis of training methodologies served as the key instrument in preparing this article, enabling a juxtaposition of the 9.9X system with existing approaches. Methods of scientific synthesis and systematization were applied to transform the authors' empirical insights, derived from extensive high-level competitive experience, into a coherent conceptual framework. To substantiate the principles and components of the model, an extensive analysis of relevant scientific literature was conducted, with the available studies logically grouped into five blocks.

In the block on the neuromechanical foundations of priming explosive actions, Blazevich and Babault [1] consistently distinguish between post-activation potentiation (PAP) and post-activation performance enhancement (PAPE): PAP is linked primarily to phosphorylation of the myosin regulatory light chain and a short-term increase in Ca^{2+} sensitivity, whereas PAPE is described as a slower multifactorial effect (temperature, hydration, excitability) requiring different temporal logistics before the start. Methenitis et al. [3] show that differences in the results of sprinters and marathoners are better explained not by the proportion but by the total percentage cross-sectional area of fast fibers: this directly indicates a morphological basis for the magnitude of PAP/PAPE and the appropriateness of explosive priming stimuli in sprinters with a large type II area. The study by Hsieh et al. [12] compares highly qualified and sub-elite young sprinters in terms of sensorimotor processing parameters at the start, using electrophysiological recording methods.

In the biomechanics of the start and the first steps, Valamatos et al. [7, art. 4074] systematize key determinants: individualized adjustment of the starting blocks and the position of the center of mass, optimal angles in the set position, an emphasis on rapid hip extension, and a slightly longer first ground contact (athlete-specific) to accrue horizontal impulse. Luo et al. [6] examine the features of specialized core training, demonstrating how it improves force transmission and trunk stability in speed-strength tasks, which is critical for block clearance and acceleration.

In the block on strength–speed interventions and load dosing, Murphy et al. [2] show meta-analytically that high-intensity resistance training, plyometrics, and resisted sprints comparably improve acceleration in team-sport athletes, and that gains in strength/power are associated with sprint improvement. Baena-Marín et al. [5] confirm the effectiveness of velocity-based resistance training (VBRT): limiting velocity loss within sets enables increases in 1RM, jump, and sprint without excessive fatigue – that is, a natural mechanism of autoregulation in the strength phase of sprinter preparation.

Methodological frameworks and tools for monitoring/autoregulation are examined by Jeffries et al. [8], who propose a revised conceptual model of training in which training effects integrate acute and chronic responses while accounting for context and load tolerance. Petro et al. [4] summarize the validity of subjective effort scales (RPE/RIR) in relation to movement velocity and relative intensity, which allows the combination of objective indicators (bar velocity, velocity-loss thresholds) and subjective indicators in day-to-day autoregulation. Belechris et al. [13] compare sprinters and middle-distance runners in terms of aerobic power and relate this difference to the mechanical variables of running, that is, to how the athlete generates and maintains effort over time.

Finally, in phase strategies for reaching peak form, Vachon et al. [10] show that a taper with maintained/emphasized intensity improves neuromuscular and metabolic indices, which is transferable to sprinting as a window for form expression and integration of PAPE protocols. Loturco et al. [9] document among Olympic-level coaches the practice of prioritizing power and speed, variability of repetitions, and substantial individualization in the competitive period – effectively a drift toward context-dependent autoregulation rather than rigid periodization. Polevoy [11] analyzes the effectiveness of unconventional training conditions as a means of optimizing strength, speed-strength, and special endurance readiness in highly qualified sprinters.

Taken together, these data delineate a phase-adaptive model: in the accumulation phase – VBRT with limited velocity loss and high-intensity strength–speed stimuli [5]; in the transmutation phase – biomechanical targets for the start and early acceleration with maintenance of trunk stiffness [6, 7] and dual-channel autoregulation by velocity and RPE [4, 8]; in the realization phase – a controlled taper and targeted PAPE protocols, especially in athletes with pronounced fast morphology [1, 3, 10].

In conclusion, it should be noted that terminological confusion between PAP and PAPE and the mismatch between their temporal windows and practical application remain sources of effect conflation [1]; the effectiveness of VBRT and high-intensity interventions for elite sprinters is still extrapolated from team-sport samples [2, 5]; the validity of core programs specifically for sprint technique requires targeted RCTs [6]; biomechanical recommendations on block setup and angles are constrained by heterogeneity of methods and reporting [7]; optimal taper scenarios and PAPE windows in world-class sprinters remain incompletely described [10]. Finally, the shift of elite practices toward autoregulation [9] still requires rigorous trial protocols within the updated conceptual model [8].

3. Results

The outcome of the analytical development is a conceptualized version of the 9.9X system–an adaptive, multilayer training model for elite sprinters. The 9.9X architecture relies on the synergistic integration of three foundational loops: phased periodization, dynamic autoregulation, and targeted neuromotor development. This combination ensures controlled dosing of the stimulus, reduces interference between qualities, and establishes a reproducible trajectory toward the competitive peak [1, 8].

The phase logic of 9.9X implements the principle of sequential transfer of adaptations: each subsequent block leverages the morphological and neural shifts accumulated earlier, thereby mitigating he simultaneous overload of multiple physiological subsystems. The base block is aimed at expanding aerobic workload and reinforcing the structures of the musculoskeletal system. In parallel, economical motor patterns at submaximal speeds are consolidated. The intensity allows the formation of working power without excessive metabolic debt. In the second, strength block, the emphasis shifts to the development of relative strength and explosive power, critical for the start and the first steps. A key method is resisted sprinting (for example, with a sled) followed by a free sprint to realize post-activation potentiation (PAP). In the special block, progressive accelerations and targeted sessions are used to practice maintaining mechanics under fatigue. The final block is peaking, characterized by a substantial reduction in volume while maintaining very high intensity, with priority on full recovery and the conversion of accumulated potential into performance.

Autoregulation constitutes the central mechanism of 9.9X adaptivity and presupposes continuous plan adjustment based on real-time feedback. The monitoring loop combines subjective indicators (rating of perceived exertion, daily questionnaires on sleep, mood, and motivation, expert appraisal of the smoothness and economy of technique) and objective markers (timed reference runs, CMJ height decrements are interpreted as substantial fatigue, as well as heart rate variability to assess autonomic strain). Integrating these channels reduces the risk of misprescribed and increases the precision of individualization [3, 10].

The Adaptive Dynamic Trigger (ADT) is the most innovative module of the system and represents a deliberately planned shock session once per week, addressing the main limiting factor of the current phase. In the base period, ADT takes the form of high-volume speed-endurance work. In the special phase, it takes the form of lactate-tolerance training. Controlled acute stress with adequate recovery initiates rapid supercompensation–a predictable micro-peak that is purposefully used for a high-quality speed session. This establishes a weekly rhythm of pinpoint stress and managed peaks, as an alternative to traditional schemes of fatigue accumulation followed by unloading.

The neuromotor component is oriented toward accelerating force development and optimizing intermuscular coordination, necessary for the effective generation and transmission of substantial horizontal and vertical forces. To this end, priority is given to sprint stimuli primarily with a fresh CNS, heavy–light contrast complexes, and tasks that complicate motor patterns (including running over mini-hurdles) to refine the spatiotemporal organization of the stride and the stability of technique at high speeds.

Local Isolated Stabilization serves as a targeted module for the deep stabilizers of the trunk, pelvic girdle, and feet. Their systematic development enhances the continuity of the kinetic chain and the quality of impulse transmission, reduces asymmetries, thereby lowering injury incidence. LIS is regarded not as a secondary addition, but as a structural precondition for the growth of specific power without technical discontinuities [2, 4].

Special Strength Preparation emphasizes exercises that are maximally close to the biomechanics of competitive sprinting: plyometrics, uphill running, and sprinting with closed resistance. The target effects are the development of extensor strength of the ankle, knee, and hip joints, increased tendon stiffness, and improved efficiency of elastic–reactive properties. This focus accelerates the transfer of strength qualities into speed, minimizing transfer losses between the weight room and the track [4, 7].

Integration of all modules is ensured through the performance loop: an express readiness assessment during the warm-up, prompt correction of session content in accordance with current markers, and subsequent analysis for planning the next day and week. This continuous cycle turns autoregulation from a declaration into an everyday process-management technology and enables 9.9X to maintain an optimal balance between stimulus and recovery throughout the entire macrocycle.

4. Discussion

The 9.9X model represents a significant advancement over traditional approaches to sprinter preparation. Its value lies not in creating new exercises, but in the rigorous synthesis of validated principles into a single, dynamic, and logically coherent architecture [1, 7]. Where classical schemes often cultivate a false opposition between rigid periodization and flexible operational planning, 9.9X demonstrates their functional complementarity. The phased structure sets the main trajectory of development, whereas autoregulation and the ADT mechanism act as real-time navigation, correcting the course based on current data.

This integration directly addresses the problem of interindividual variability; instead of enforced adherence to a pre-fixed plan, the performance loop provides continuous optimization of the training dose in accordance with the athlete's current state [4, 7]. This cycle is illustrated in Figure 1, which visualizes the cyclicity of the adaptation process.

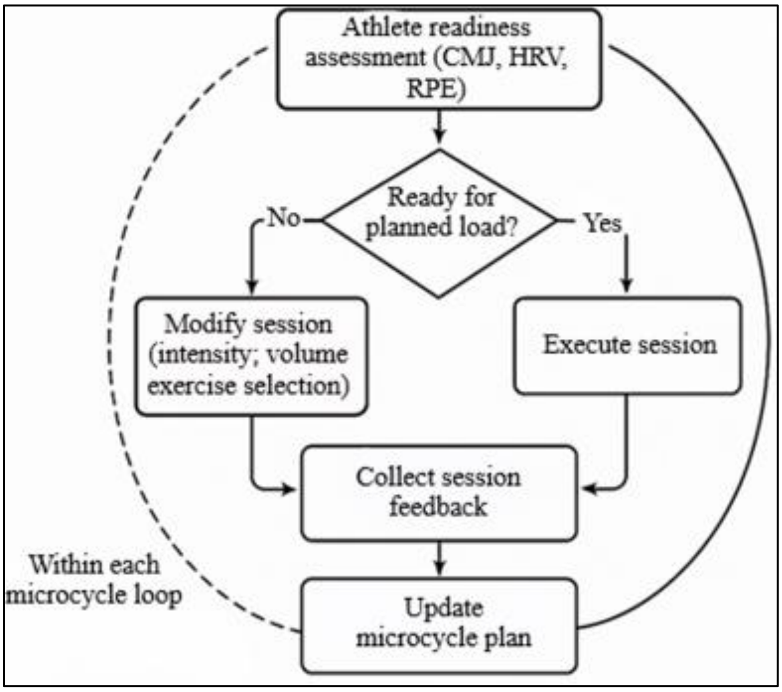

Figure 1 Adaptive training cycle ("Performance Loop") in the 9.9X model [1, 4, 7]

The principal innovation of the system is the Adaptive Dynamic Trigger (ADT). In traditional periodization, the emphasis is placed on 2–3-week blocks of functional overreaching followed by a longer recovery. This scheme is effective for producing a single peak of form but is characterized by high fatigue. Drawing on evidence that high-intensity strength and power interventions can meaningfully improve sprint performance in team sport athletes [2], ADT rethinks this logic at the micro level: once per week, a deliberately potent stimulus is introduced that triggers a rapid, controlled supercompensation within the current phase.

The viability of the model directly depends on the athlete's ability to adapt to intense weekly stressors. At this critical point, the integration of neuromotor adaptation, LIS, and SSP comes to the forefront: it is precisely their joint action that forms a quality that can be designated as neurostructural robustness. This is not a sum of strength and stability, but a dynamic capacity to maintain technical accuracy and transmit force without loss under pronounced neuromuscular fatigue. LIS builds a resilient structural foundation, SSP develops the primary power-generation mechanisms, and neuromotor training optimizes the control systems. Without this basic configuration, the regular application of ADT would predictably increase the risk of injury [3, 10]. The specified synergy constitutes the theoretical core of 9.9X robustness and is visualized in Figure 2.

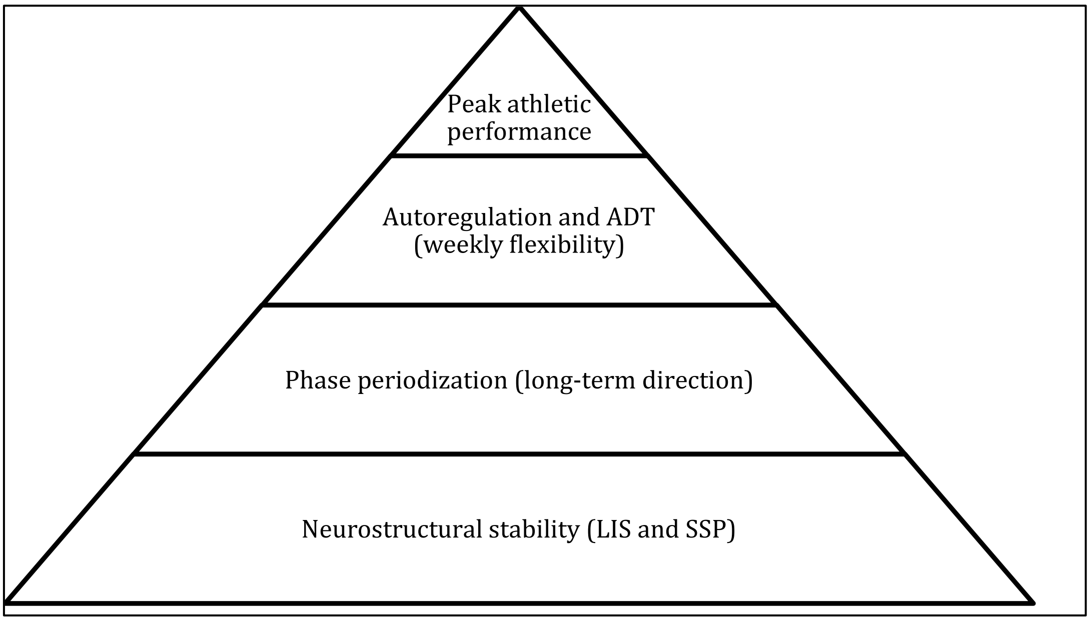

Figure 2 The synergetic pyramid of the 9.9X model [2, 3, 10]

The presented pyramid emphasizes that the apex of performance is achieved not by the efforts of a single element, but through the coordinated integration of all components of the system.

Below, Table 1 will be presented, demonstrating the key advantages, disadvantages, and prospective trends for the three components: the phased approach, neuromotor adaptation, and autoregulation.

Table 1 Adaptive model for elite sprinter preparation: advantages, risks, and future trends of the phase-based approach, neuromotor adaptation, and autoregulation [5, 6, 9]

Component	Advantages	Limitations/risks	Future directions
Base period (60–80% VO2max/power)	• Builds an aerobic base → faster recovery between speed days. • Strengthens the musculoskeletal system/tendons (sand jumps, LIS) → lower injury	• Excessive aerobic work blurs the speed profile, reduces Vmax. • Risk of monotony and underloading speed; technique may not transfer to fast running. • Errors in dosing jumps/hurdles → overload	• Embedded load monitoring: HRV+RPE, simple field metrics (contact time, step frequency). • Individualization of interval volume by sprinter profile (buffer vs power).

	rates in subsequent phases. • Technique practice at moderate speed; rhythm/coordination over hurdles. • Lays the volume foundation for subsequent strength/speed adaptations.	of the ankle joint/anterior shin.	
Strength adaptation phase (80–90% of max.)	• Increase in relative strength and propulsive power; improved acceleration. • Contrast sled → free sprint enhances transfer of force to speed. • Increases the mechanical robustness of tendons/posterior chain → lower risk of hamstring injuries.	• Overload of the Achilles/hamstrings with abrupt increases in sled resistance. • Heavy sleds alter step mechanics (over-stride); possible interference with speed. • Accumulation of CNS fatigue with incorrect placement of strength/contrasts within the week.	• Calibration of sled resistance to the individual F–V profile. • Tracking bar velocity/first acceleration and auto-stopping sets at thresholds.
Special preparation phase (90–97% of max.)	• Increase in competitive speed and speed endurance. • Maintenance of mechanics at high speeds and under lactate stress (ADT). • 80 m progressions and contrasts develop Vmax and its maintenance.	• High peak loads on the CNS/connective tissue → injury risk. • Error in dosing ADT/recovery window leads to prolonged fatigue and speed decline. • Technique breakdown on final reps with excessive volume/intensity.	• Precise timing and step metrics (Freelap/video) with auto-stop thresholds (drop in speed/step frequency). • Individual lactate windows and microdosing of volume; probabilistic readiness assessment (CMJ/HRV/first sprint). • Expansion of variable sensory conditions (surface/wind) to stabilize technique.
Peaking phase (95–100% of max.)	• Maximization of speed and freshness for the start. • Neural potentiation at minimal volume; rehearsal of starting procedures. • Minimization of fatigue while maintaining quality.	• Risk of underloading and loss of tone with excessive easing of the week. • High intensity of single runs raises the risk of micro-damage without sufficient priming. • Timing errors with light technical work/LIS → loss of sharpness. • Circadian disruptions due to travel/climate.	• Personalized taper by response to priming. • Management of light/temperature/hydration and start time; minimally sufficient doses of LIS, coupling with SSP to preserve tendon stiffness.

Thus, it can be stated that the 9.9X model is a complex, scientifically grounded construct that surpasses the constraints of prescriptive programs. Reconceptualizing the training process as a dynamic system based on neurostructural stability and governed by a continuous performance loop, it offers an applied methodology for developing an elite sprinter. The key to unlocking the potential of the athlete is determined not by an ideal plan but by a flawlessly organized process of adaptation.

5. Conclusion

The article formulates and theoretically substantiates the 9.9X system – an adaptive platform for preparing world-class sprinters. Classical training schemes, despite their historical effectiveness, are insufficiently sensitive to pronounced interindividual variability. Their normative rigidity often leads to suboptimal adaptation and increased injury incidence, underscoring the imperative to transition to more dynamic, context-dependent models.

A four-phase periodization ensures a sequential progression from the foundation of general preparation to the attainment of peak speed metrics. The key mechanism is presented as adaptive dynamic triggering (ADT), which creates weekly local maxima of performance capacity and thereby enables an increase in the frequency and quality of target training stimuli.

As a result, the 9.9X method constitutes an integrated system for preparing a world-class sprinter, built on the synergy of a phasic model, autoregulation, ADT, neuromotor adaptation, LIS, and SSP. The potential benefit for the USA lies in the following factors:

- Enables the preparation of athletes capable of competing at the international level, including the Olympic Games and World Championships.
- Implementation of an innovative model in coaching practice, which will contribute to strengthening the USA's position as a global center of track and field.
- The creation of educational programs and methodological materials for young coaches and athletes will ensure the long-term growth of the country's athletic potential.

Integration into the world elite is made possible by the modular structure of the methodology: elements of 9.9X are easily adapted to any conditions – from national teams to youth academies. In the longer term, the methodology can become one of the benchmarks of preparation in global sprinting, combining scientific validity, practical effectiveness, and robustness of outcomes.

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