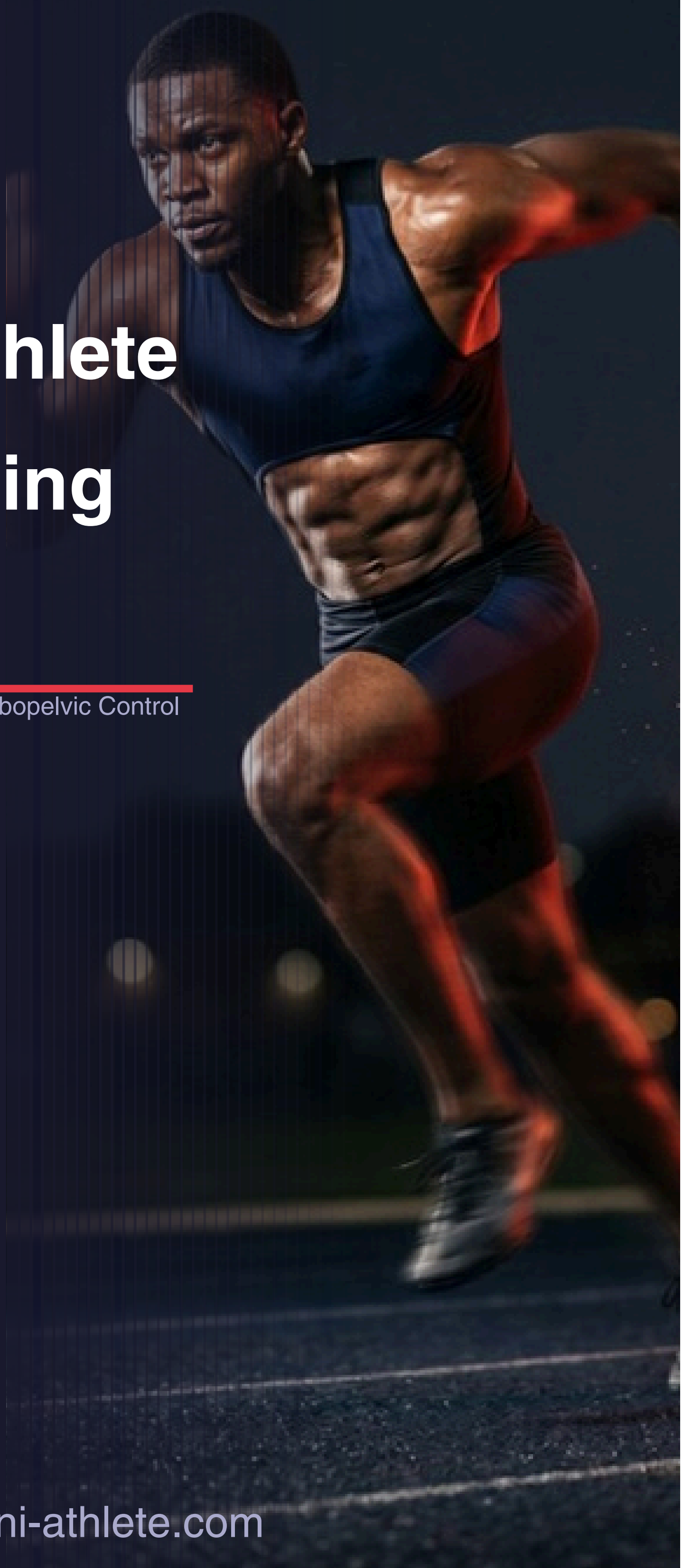
FREE GUIDE

The Omniathlete Trunk Training Framework

Strength · Stiffness Modulation · Lumbopelvic Control



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Foreword

This guide emerged from a simple observation: the language coaches and practitioners use to describe trunk function rarely matches the complexity of what the trunk actually does. Terms like 'core stability', 'bracing', and 'neutral spine' have become so embedded in training culture that they are often accepted as self-evident truths rather than examined as working hypotheses.

The Omniathlete approach to trunk training is grounded in systems thinking — the recognition that athletic movement arises from the interaction of multiple subsystems operating in parallel, not from isolated muscles or rigid mechanical blueprints. From this vantage point, the trunk is not a passive stabiliser waiting to be 'activated'. It is an active, adaptive hub that continuously modulates its behaviour in response to task demands, fatigue, context, and intent.

This guide organises trunk training around three interconnected pillars: Trunk Strength, Stiffness Modulation, and Lumbopelvic Control. These pillars do not represent separate anatomical regions or muscle groups. They represent functional behaviours — patterns of output that the trunk must be capable of expressing across a wide range of sporting contexts. Developing all three, and understanding how they relate to one another, is what distinguishes a coherent trunk training strategy from a collection of exercises labelled 'core work'.

The target audience for this guide is practitioners: strength and conditioning coaches, sport scientists, physiotherapists, and coaches who work with athletes across disciplines. The content is deliberately practical, but it is rooted in conceptual clarity. The goal is not to provide a ready-made programme to be applied without modification. It is to offer a framework — a way of thinking — that can be adapted to the athletes, sports, and environments you work with.

> ***"The trunk is not a problem to be solved. It is a system to be developed — one that must be strong enough to handle load, responsive enough to modulate stiffness in real time, and coordinated enough to sequence motion efficiently across segments."***

A note on terminology: throughout this guide we use the word 'trunk' rather than 'core'. This choice is intentional. 'Core' carries too much conceptual baggage — it implies a single, circumscribed anatomical unit with a singular function. 'Trunk' is more anatomically accurate and, more importantly, more functionally honest.

TRUNK STRENGTH

- Load tolerance
- Force transmission
- Posterior chain
- Anti-rotation

STIFFNESS MODULATION

- Timing & reactivity
- Elastic capacity
- IAP control
- Perturbation response

LUMBOPELVIC CONTROL

- Sagittal alignment
- Frontal stability
- Rotational sequencing
- Segment coordination

Figure 1. The Omniathlete Three-Pillar Trunk Framework

CHAPTER 1

Rethinking the Trunk: Beyond Core Stability

The Problem with 'Core Stability'

The concept of core stability entered mainstream sports medicine and strength training largely through the work of researchers at the University of Queensland in the 1990s, who investigated the role of transversus abdominis and multifidus in anticipatory postural adjustments (Hodges & Richardson, 1997). Their findings — that these muscles fire slightly before limb movement in healthy subjects and with a delay in those with low back pain — were sound and meaningful in the clinical context in which they were generated.

What followed, however, was a progressive distortion of those findings as they migrated into coaching and performance practice. 'Activate your transversus abdominis' became standard cueing. 'Hollow your stomach' and 'draw in your navel' entered the lexicon of group fitness classes and physiotherapy clinics alike. The construct of 'core stability' — a term the original researchers used cautiously and in a specific clinical sense — was repackaged into a general framework claiming that a weak or dysfunctional 'core' was responsible for a wide range of athletic limitations and injury risk.

The evidence base for these broader claims has proved considerably weaker than the original clinical findings. Systematic reviews and meta-analyses have found that core-specific training programmes produce modest and context-dependent improvements in athletic performance, and that the relationship between measures of 'core stability' and injury incidence is not as robust as originally proposed (Prieske *et al.*, 2016; Wirth *et al.*, 2017). More importantly, the theoretical model underpinning much of this work — that the spine requires stabilisation from a dedicated set of 'inner unit' muscles — oversimplifies the distributed, adaptive nature of motor control.

Movement as an Emergent Property

Human movement is not produced by sequentially activating discrete muscles in a pre-programmed order. It emerges from the interaction of the neuromuscular system with the task, the environment, and the body's own mechanical properties. This emergence is a fundamental feature of complex adaptive systems (Kelso, 1995). It means that the 'right' trunk behaviour in a given moment is not a fixed prescription but a context-sensitive solution arrived at by the nervous system based on the demands of the situation.

From this perspective, the goal of trunk training is not to teach the nervous system a single 'correct' pattern of muscle recruitment. It is to expand the athlete's repertoire of available solutions — to build a trunk that can be stiff when stiffness is required, supple when suppleness is required, and coordinated across segments when coordination is the primary demand. Variability, in this framework, is not a problem to be eliminated. It is a resource to be cultivated.

Trunk training, from a systems perspective, is about developing capacity across multiple behavioural dimensions — not about installing a preferred pattern of muscle activation.

What the Trunk Actually Does

The trunk serves at least three distinct functional roles in athletic movement. First, it transmits and modulates forces between the lower and upper body. In any task involving the entire kinetic chain — sprinting, jumping, striking, throwing — energy must travel through the trunk. The efficiency of this transmission depends on the trunk's capacity to generate sufficient stiffness at the right moment and in the right plane.

Second, the trunk contributes to whole-body postural orientation. The position and behaviour of the thorax, lumbar spine, and pelvis collectively influence the mechanical advantage of the hip and shoulder musculature, and affect the efficiency of limb movements. Lumbopelvic alignment during a sprint, for example, is not incidental — it shapes the length-tension relationship of the hip extensors and the ground reaction force vector.

Third, the trunk serves as a site of energy storage and release in rapid, cyclical movements. The elastic properties of the thoracolumbar fascia, the passive stiffness of the spine's ligamentous structures, and the stretch-shortening cycle of trunk musculature all contribute to the efficiency of running, throwing, and rotational sport actions (Vleeming *et al.*, 2012).

Reframing the Framework

The three-pillar framework presented in this guide — Trunk Strength, Stiffness Modulation, and Lumbopelvic Control — organises training around these functional roles rather than around anatomical structures or simplified mechanical models. Each pillar addresses a distinct behavioural demand, and each can be developed through targeted training. Together, they produce a trunk that is robust, adaptive, and sport-relevant.

This does not mean that anatomy is irrelevant. Understanding which muscles contribute to force transmission, stiffness regulation, and pelvic control remains important for exercise selection and coaching. The point is that anatomy should inform the design of training, not constrain it to a reductionist model in which the trunk is treated as a collection of isolated components to be separately activated.

CHAPTER 2

Trunk Anatomy Through a Systems Lens

Three Subsystems, One Integrated Unit

A useful anatomical model for the trunk— one that avoids the reductionism of muscle-by-muscle analysis — divides the spinal stabilisation system into three interacting subsystems: the passive osteoligamentous system, the active musculotendinous system, and the neural control system (Panjabi, 1992). These three subsystems work continuously in concert. The failure of any one demands compensatory behaviour from the others — which may explain why the relationship between any single measure of trunk function and clinical or performance outcomes tends to be modest: the system compensates.

The passive system comprises the vertebrae, intervertebral discs, facet joints, and ligaments. It provides stiffness and load-bearing capacity near the end ranges of motion but contributes relatively little to stability in the neutral zone — the mid-range of movement where most athletic tasks occur. This means the active musculotendinous system must supply the majority of stability during dynamic sport actions.

The Active System: A Functional Map

Rather than cataloguing individual muscles, it is more useful to organise the trunk's active musculature by functional role. Three broad categories are relevant to athletic performance.

Global Force Producers

The global musculature— rectus abdominis, external and internal obliques, erector spinae, and gluteal musculature — generates large forces and moves the spine and pelvis through their full range of motion. These muscles have long moment arms relative to the spine and are the primary contributors to force transmission tasks such as sprinting, jumping, and striking. Training the global system is the foundation of trunk strength development.

Local Force Modulators

The local musculature— transversus abdominis, multifidus, the diaphragm, and pelvic floor musculature — regulates intra-abdominal pressure and fine-tunes segmental stiffness. Their contribution to gross force production is small, but their role in modulating the mechanical environment within which the global muscles operate is significant. These muscles are best developed through progressive loading of integrated movements rather than isolated activation drills.

Coupling Structures

The thoracolumbar fascia connects the latissimus dorsi, gluteus maximus, and contralateral gluteus medius through a mechanical coupling that is particularly relevant during running and throwing. The sacroiliac joint and its associated ligamentous system transfer load between the spine and the lower limb. These structures do not produce movement; they transmit it. Their function is optimised by building sufficient stiffness and coordination through the surrounding musculature.

The Neural Control System

Muscle activity is only as effective as the neural signals that drive it. The neural control system continuously monitors spinal position and load through mechanoreceptors in muscles, ligaments, and disc tissue, and adjusts muscle activity accordingly. This feed-forward and feedback control loop is what allows the trunk to respond to perturbations and anticipate the mechanical demands of upcoming movements.

Training this system requires exposure to variability — perturbations, asymmetrical loads, reactive tasks — that challenge the nervous system to generate appropriate motor solutions. A training programme that exclusively uses predictable, bilateral, slow-velocity exercises will develop capacity in the passive and active subsystems but may leave the neural control system under-challenged for the reactive demands of sport.

The Lumbopelvic-Hip Complex

A particularly important anatomical unit for athletic performance is the lumbopelvic-hip complex — the functional coupling between the lumbar spine, pelvis, and hip joint. Pelvic orientation directly influences hip range of motion, the mechanical advantage of the hip extensors, and the transmission of ground reaction forces during locomotion. Anterior pelvic tilt is associated with increased hip flexor length-tension advantage but may compromise hip extensor function; posterior tilt has the opposite profile.

Critically, neither orientation is universally 'correct'. The appropriate pelvic position varies with the task, the phase of movement, and the individual athlete's morphology. The goal of training is not to normalise pelvic position to a fixed target, but to develop the capacity to adopt and transition between appropriate positions across the demands of sport.

Anatomy informs exercise selection. It should not constrain it. The trunk's multiple subsystems work as an integrated unit — training should respect that integration.

CHAPTER 3

Pillar 1: Trunk Strength

Trunk strength is the structural and neuromuscular capacity to handle external loads, maintain segment alignment, and transmit force efficiently between the lower and upper body. It is the foundation upon which the other two pillars are built: without sufficient load tolerance, stiffness modulation becomes unreliable and lumbopelvic control degrades under fatigue.

What Trunk Strength Is — and What Is Not

Trunk strength is not the same as the ability to produce a maximal crunch, or to maintain a plank for an extended duration, or to score highly on a single-plane functional screen. These measures may correlate with some aspects of trunk capacity, but they do not capture the multi-plane, multi-joint nature of strength expression in sport.

In athletic contexts, trunk strength manifests primarily as the ability to resist unwanted motion under load — anti-flexion, anti-extension, anti-rotation, and anti-lateral-flexion — while maintaining the alignment that allows force to travel efficiently through the kinetic chain. This is sometimes framed as 'proximal stability for distal mobility': a stable, strong trunk provides the mechanical base from which limb movements can be generated powerfully and precisely.

Loaded Carries: The Foundation

Loaded carry variations are among the most transferable trunk strength exercises available to the strength and conditioning practitioner. They impose continuous anti-lateral-flexion and anti-rotation demands, require the athlete to maintain alignment while in motion, and develop the grip strength, shoulder stability, and lower-limb robustness that accompany sport performance. Their simplicity is deceptive: the farmer's carry, performed with genuinely heavy loads, is a whole-system exercise that exposes weaknesses in alignment and tolerance that more controlled bilateral lifts may not reveal.

The suitcase carry — a unilateral farmer's carry — places a greater anti-lateral-flexion demand on the contralateral trunk and imposes an asymmetrical challenge similar to that experienced during single-leg stance phases in sprinting, cutting, and kicking. The overhead carry adds thoracic extension and shoulder stability requirements. These variations can be progressed systematically by increasing load, distance, and pace.

Hip-Dominant Strength

The integration of hip and trunk extension is a fundamental movement pattern for virtually every power-demanding sport action. Romanian deadlifts, trap-bar deadlifts, single-leg RDLs, and split squats develop the posterior-chain capacity that underpins sprinting, jumping, and change of direction. In all of these exercises, the trunk serves as a force transmitter: the gluteal and hamstring musculature generates hip extension torque, and the trunk must be sufficiently stiff to channel that force into the kinetic chain without energy loss through unwanted spinal flexion.

Progressive overload in these exercises — through load, range, tempo, and unilateral variation — develops the trunk's anti-flexion capacity more effectively than isolated flexion-extension exercises such as crunches or sit-ups, because the mechanical demand is applied through the spine's functional role as a load-transmitting column rather than as a lever producing sagittal-plane motion.

Anti-Rotation Strength

Rotational sport actions — kicking, throwing, striking — require the trunk to produce and control rotation. But they also require the capacity to resist unwanted rotation in non-rotational contexts such as acceleration, deceleration, and change of direction. Anti-rotation exercises — Pallof press variations, cable holds, landmine holds, and asymmetrically loaded carries — develop this resistance capacity.

The Pallof press is a useful coaching tool because it makes the anti-rotation demand explicit and adjustable. Load, stance, height, and angle can all be varied to shift the primary challenge between trunk, hip, and shoulder. More importantly, it develops the athlete's awareness of their baseline rotational alignment — a prerequisite for effective lumbopelvic control during sport tasks.

Exercise Type	Example Exercises	Coaching Focus	Primary Adaptation
Loaded Carries	Farmer's carry, suitcase carry, overhead carry, yoke carry	Maintain alignment under load; resist lateral trunk flexion	Whole-system load tolerance; anti-lateral-flexion capacity
Hip-Dominant Strength	Romanian deadlift, trap-bar deadlift, split squat, single-leg RDL	Integrate hip and trunk extension; control pelvic position	Posterior-chain strength; anti-flexion capacity
Anti-Rotation Strength	Pallof press, cable holds, landmine holds, asymmetric carries	Maintain trunk orientation under asymmetrical load	Rotational stiffness; proximal stability
Anti-Flexion Strength	Back extensions, good mornings, prone plank progressions	Resist sagittal-plane flexion under load	Erector spinae and posterior-chain endurance
Anti-Extension Strength	Ab wheel rollouts, stir-the-pot, body saw	Resist lumbar hyperextension; maintain pelvic position	Anterior chain strength; lumbopelvic alignment

Programming Trunk Strength

Trunk strength exercises should generally be placed early in the training session, when fatigue is lowest and motor control is least compromised. In strength-focused training phases, they may be performed as primary movements with meaningful progressive overload. In speed-focused or technical phases, they are better used as supplementary work placed after primary speed or skill development, keeping volume and intensity moderate to avoid interfering with motor learning.

Repetition ranges for strength development in the trunk are broadly consistent with those for other muscle groups: 3–6 sets of 3–8 repetitions for maximal strength adaptation, with sufficient rest between sets to allow quality movement. The temptation to use high repetition ranges for trunk work — perhaps out of a lingering association with 'endurance training' — should be resisted in athletes whose primary demand is force production rather than postural endurance.

CHAPTER 4

Pillar 2: Stiffness Modulation

Stiffness modulation is the trunk's capacity to rapidly adjust its mechanical stiffness in response to changing task demands. It is, in many ways, the most distinctively athletic quality of the three pillars — because it is the one most closely tied to the speed, reactivity, and unpredictability of competitive sport.

Understanding Stiffness in Athletic Contexts

Mechanical stiffness refers to the resistance of a structure to deformation under load. In the trunk, stiffness is produced through co-contraction of the surrounding musculature: the greater the co-contraction, the stiffer the trunk becomes. This stiffness is valuable during brief high-force events — a ground contact during sprinting, the moment of impact in a contact sport, the instant of ball strike — because it enables efficient force transmission without energy loss through unwanted segmental motion.

However, sustained maximal trunk stiffness is energetically costly and mechanically counterproductive. An athlete who maintains near-maximal trunk co-contraction throughout a movement — as might be recommended by overly simplistic 'brace the core' cueing — will sacrifice fluid limb movement, respiratory efficiency, and the capacity to accept and redirect forces across the kinetic chain. The skill is not to be maximally stiff, but to be stiff at the right moment and supple in the moments between.

The critical variable in stiffness modulation is timing — not magnitude. An athlete who can produce high trunk stiffness for 50 milliseconds at precisely the right phase of a ground contact is better served than one who is moderately stiff throughout.

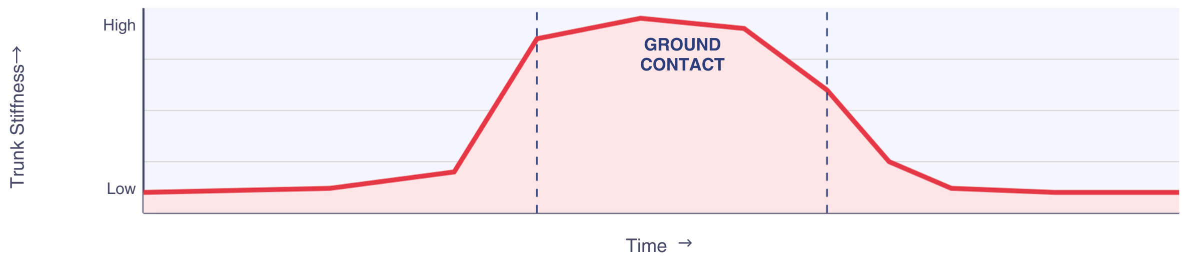

Figure 3. Schematic trunk stiffness profile during a sprint stride cycle

The Stretch-Shortening Cycle and Elastic Contributions

Many athletic trunk actions involve the storage and release of elastic energy. During rotational movements — a throwing or kicking action, for example — the trunk muscles are pre-stretched as the pelvis leads the thorax, and subsequently release elastic energy as the thorax accelerates. The efficiency of this process depends on the mechanical stiffness of the trunk musculature during the eccentric phase: a stiffer pre-stretch stores more energy for subsequent release.

This elastic contribution is also relevant during running. The thoracolumbar fascia and the passive stiffness of the posterior chain contribute to the spring-like behaviour of the trunk during the stance phase of running, reducing the metabolic cost of locomotion. Training that develops the trunk's capacity to rapidly stiffen and release — through medicine ball throws, reactive perturbation drills, and plyometric progressions — develops this elastic function alongside the neural timing that governs it.

Training Stiffness Modulation

Exercises for stiffness modulation differ from exercises for trunk strength in their emphasis. Where trunk strength training prioritises load tolerance and alignment under progressive resistance, stiffness modulation training prioritises timing, reactivity, and the capacity to transition rapidly between stiff and supple states.

Perturbation Drills

Perturbation drills — partner taps, band flicks, unstable surface holds, reactive balance tasks — challenge the neural control system to generate appropriate stiffness responses to unpredictable loads. Their value lies not in the magnitude of load they impose, which is typically modest, but in the variability of the challenge and the demands this places on reactive motor control.

Medicine Ball Throws

Rotational, overhead, and scoop medicine ball throw variations develop the rapid stiffness required to transfer force from the lower body through the trunk and into the upper extremity. The key coaching focus is not maximal throw velocity per se, but the quality of trunk bracing during the force transfer phase and the deceleration task that follows. Progressions can introduce asymmetry, unstable positioning, or reactive components — catching and immediately redirecting — to increase complexity.

Plyometric and Reactive Strength Progressions

Countermovement jumps, hurdle hops, and plyometric push-up variations develop the trunk's capacity to contribute to the stretch-shortening cycle in global athletic actions. During these exercises, the trunk must stiffen transiently to transmit ground reaction forces from the lower body, then relax sufficiently to allow fluid limb cycling during the flight phase.

Exercise Type	Example Exercises	Primary Mechanism	Coaching Cue
Perturbation Drills	Partner taps, band flicks, reactive holds, unstable plank variations	Neural timing; reactive stiffness	React, don't anticipate
Medicine Ball Throws	Rotational throw, overhead slam, scoop throw, catch-and-redirect	Rapid force transfer; elastic storage	Drive from the ground, brace through contact
Plyometric Progressions	CMJ, hurdle hops, plyometric push-ups, reactive landings	Stretch-shortening cycle; elastic contribution	Minimise contact time; stay tall
Sprint Mechanic Drills	A-march, A-skip, wicket runs, resisted sprint holds	Trunk stiffness during ground contact	Rigid torso, free limbs
Isometric Challenges	Loaded plank holds at transition points, anti-rotation isometrics	Sustained stiffness under positional demand	Control breathing; maintain position

Breathing and Intra-Abdominal Pressure

Intra-abdominal pressure (IAP) is a primary mechanism through which the trunk generates stiffness rapidly. IAP is increased by co-contraction of the diaphragm, pelvic floor, and abdominal wall musculature, and this increase substantially raises spinal stiffness without requiring maximal activation of the spinal extensors. The Valsalva manoeuvre, used in maximal lifting, produces the highest IAP but is unsustainable over multiple breath cycles and inappropriate for most athletic contexts.

For athletes, developing the ability to control breathing while maintaining trunk stiffness is a practically important — and often neglected — skill. In many sport contexts, the athlete cannot hold their breath to brace maximally: they must maintain appropriate trunk stiffness across a breathing cycle. Training this capacity through timed breathing patterns during loaded exercises, and through exercises that impose trunk demands across varied respiratory phases, is a meaningful addition to the stiffness modulation training menu.

CHAPTER 5

Pillar 3: Lumbopelvic Control

Lumbopelvic control refers to the coordinated management of relative motion between the lumbar spine, pelvis, and hip complex across the demands of sport. It addresses the 'how' of trunk movement rather than simply the 'how much': not whether the trunk can resist load, but whether it can sequence motion efficiently, maintain appropriate alignment during single-leg and rotational tasks, and support the technical execution of sport-specific skills.

Why Lumbopelvic Control Matters

Inefficient lumbopelvic patterns manifest in many different ways in athletic contexts. Excessive anterior pelvic tilt during acceleration may reduce hip extensor mechanical advantage and increase compressive loading on the lumbar spine. Contralateral pelvic drop during single-leg stance phases — commonly called the Trendelenburg sign — reduces the efficiency of gluteal force production and alters lower limb alignment during ground contact. Premature lumbar rotation relative to the pelvis during throwing or kicking may reduce the velocity of the proximal-to-distal energy transfer.

These patterns are not necessarily injurious, and their relationship with injury risk is more complex than is sometimes portrayed. But they do represent energy leaks — instances where force is dissipated through unintended motion rather than channelled toward the intended task. Training lumbopelvic control is therefore as much about performance efficiency as it is about injury management.

Sagittal Plane Control: Anterior/Posterior Pelvic Tilt

The ability to control pelvic orientation in the sagittal plane is a prerequisite for efficient hip function. Hip-dominant exercises — RDLs, split squats, step-ups — develop this capacity when coached with attention to pelvic position throughout the movement. Dead bug variations and their progressions are useful for developing the specific capacity to maintain posterior pelvic tilt against the destabilising influence of limb loads. The key adaptation sought is not the ability to sustain a posterior pelvic position in isolation, but the ability to return to an appropriate pelvic orientation rapidly when it is perturbed — which is the actual demand in sport.

Frontal Plane Control: Lateral Pelvic Stability

Single-leg stance tasks — running, jumping, cutting, kicking — impose large frontal-plane demands on the trunk and pelvis. The abductors of the standing leg, particularly gluteus medius and minimus, resist the lateral pelvic drop that would otherwise occur as the body's centre of mass passes over the stance foot. When these muscles are insufficiently strong or activated with poor timing, the pelvis drops toward the swing leg — an energy-inefficient pattern that places compensatory demands on the trunk and alters lower limb mechanics.

Single-leg RDL variations are among the most effective exercises for developing this capacity, because they require the athlete to maintain a level pelvis while managing the rotational challenge of unilateral hip hinge. Split-stance anti-rotation holds extend this capacity to include simultaneous frontal and transverse plane demands.

Transverse Plane Control: Rotation and Counter-Rotation

Rotational sport actions require the trunk to produce, transmit, and decelerate rotation efficiently. The key mechanical event in most rotational skills is the separation angle between the pelvis and the thorax — the pelvis leads, the thorax follows, and the sequential acceleration of each segment generates the proximal-to-distal velocity transfer that produces high limb speeds. Training the capacity to control this sequencing — to allow appropriate pelvis-thorax separation while decelerating efficiently at the end of the movement — is the primary goal of rotational control training.

Cable rotations, medicine ball side throws, and rotational landmine variations develop this capacity across a range of loading and velocity conditions. The deceleration component — the 'catch' at the end of the throw — is often neglected but is mechanically important: the muscles that decelerate rotation are frequently the same muscles that subsequently produce it, and their eccentric capacity is a determinant of the speed and safety of the subsequent concentric action.

Exercise Type	Example Exercises	Plane of Demand	Key Adaptation
Sagittal Control	Dead bug, RDL, split squat, posterior pelvic tilt holds	Sagittal (anterior/posterior tilt)	Anterior chain endurance; hip-trunk coupling
Frontal Plane Stability	Single-leg RDL, lateral plank, side-lying hip abduction, suitcase carry	Frontal (lateral pelvic drop)	Hip abductor strength; unilateral trunk control
Rotational Control	Cable rotations, medicine ball side throw, landmine rotation	Transverse (pelvis-thorax separation)	Sequential segment acceleration; eccentric deceleration
Integrated Coordination	Walking lunge with rotation, step-up with reach, contralateral limb patterns	Multi-plane	Trunk-pelvis-hip coordination across movement
Anti-Rotation Holds	Split-stance Pallof, single-leg anti-rotation cable holds	Transverse (resistance to rotation)	Transverse plane stiffness during single-leg tasks

Integrating Lumbopelvic Control with Global Training

Lumbopelvic control is not best trained in isolation. Isolated exercises — pelvic tilts on a mat, clam shells in a side-lying position — may serve a purpose in an early rehabilitation context, but they are a poor match for the demands of sport, where lumbopelvic control must be expressed under load, in motion, and in response to unpredictable external forces. The transition from isolated to integrated training should be made as quickly as the athlete's capacity allows.

Practically, this means designing exercises that place lumbopelvic control demands within the context of whole-body movements: single-leg carrying variations, rotational landmine exercises combined with split squat positioning, or reactive single-leg landing tasks. The goal is to develop the athlete's capacity to maintain appropriate trunk-pelvic coordination not just when asked to do so in a controlled environment, but under the competing demands of load, speed, and cognitive attention that characterise competitive performance.

CHAPTER 6

Integrating the Three Pillars

The three-pillar framework is not a menu of interchangeable options. It is a coherent system in which each pillar supports and constrains the others. Trunk strength provides the structural foundation that makes stiffness modulation reliable and lumbopelvic control durable under fatigue. Stiffness modulation activates the trunk's elastic and reactive capacity that raw strength alone cannot develop. Lumbopelvic control refines the mechanical alignment within which both strength and stiffness operate. Training them together — in proportions appropriate to the athlete's current capacity and the demands of their sport — produces an integrated trunk that is more than the sum of its parts.

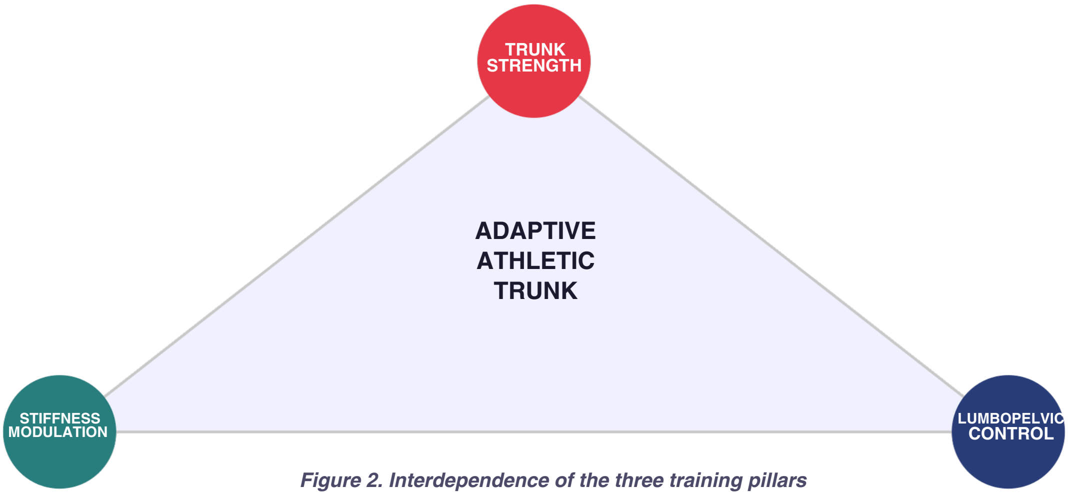

Figure 2. Interdependence of the three training pillars

How the Pillars Interact

Consider a common athletic scenario: a footballer receiving a body challenge during a ball strike. In this moment, the trunk must simultaneously maintain sufficient stiffness to resist the perturbation (stiffness modulation), preserve pelvic alignment to keep the striking leg's mechanical advantage intact (lumbopelvic control), and tolerate the compressive and shear loads produced by the contact (trunk strength). Each pillar is in play simultaneously. An athlete who has trained all three — and who has trained them in combination — is more likely to execute the skill efficiently and absorb the contact safely than one who has prioritised only one dimension of trunk function.

The interaction between pillars also means that deficiencies in one will eventually compromise the others. An athlete with strong trunk musculature but poor stiffness modulation timing may perform well on isolated strength tests but underperform in the reactive, unpredictable demands of competition. An athlete with good rotational control in isolation may lose that control when fatigued — revealing a deficit in the strength base that underpins coordination under load.

Integration is not simply mixing exercises from each pillar in a single session. It requires understanding which pillar is the limiting factor for a given athlete at a given point in time, and prioritising accordingly — while maintaining a minimum effective volume in the other two.

Session Structure

A practical approach to integrating the three pillars within a training session begins with a brief trunk movement preparation sequence in the warm-up, focused on lumbopelvic awareness and light stiffness modulation tasks. This primes the neural control system and establishes appropriate alignment before the demands of the primary training section.

The primary strength work — whether speed-, power-, or strength-focused — provides an implicit trunk training stimulus when programmed appropriately. Loaded carries, hip-dominant bilateral and unilateral lifts, and anti-rotation work can be incorporated as primary or supplementary exercises depending on the session focus. Explicit stiffness modulation work — medicine ball throws, perturbation drills — is generally best placed in the early part of the main section, when neuromuscular output is highest.

Session Section	Primary Pillar	Example Exercises	Volume Guidance
Warm-Up / Movement Preparation	Lumbopelvic Control	Dead bug, glute bridge, single-leg balance, pelvic awareness cues	2–3 exercises; 1–2 sets; low load
Main Section (Power/Speed)	Stiffness Modulation	Medicine ball throws, reactive perturbations, sprint drills	3–5 exercises; 2–4 sets; high velocity
Main Section (Strength)	Trunk Strength	Trap-bar DL, split squat, suitcase carry, Pallof press	3–5 exercises; 3–6 sets; progressive load
Supplementary Section	Lumbopelvic Control / Integration	Single-leg RDL, rotational cable, step-up with reach	2–3 exercises; 2–4 sets; moderate load
Finisher (optional)	Trunk Strength Endurance	Loaded carry distance, anti-rotation plank hold, body saw	1–2 exercises; 1–3 sets; moderate load

Managing Fatigue and Transfer

Trunk training interacts with the wider training load in ways that are not always immediately visible. High-volume trunk strength work on consecutive days may impair the quality of speed and power sessions by elevating local fatigue in the posterior chain and trunk musculature. Equally, heavy lower-body strength sessions impose substantial trunk loading that should be accounted for when calculating total training stress.

A pragmatic approach is to treat trunk training as integrated with — rather than separate from — the overall training programme. When the programme includes heavy bilateral lifts, loaded carries may be unnecessary in the same session. When the programme is predominantly speed-focused, an explicit trunk strength section may be warranted to maintain load tolerance. The goal is not to maximise trunk training volume, but to ensure sufficient stimulus across all three pillars without compromising the athlete's capacity to perform the sport-specific training that drives long-term performance adaptation.

CHAPTER 7

Programming and Periodization

Trunk training should be periodised — not in the sense of elaborate periodization structures unique to the trunk, but in the sense that its emphasis, volume, and intensity should vary in proportion to the overall training phase and the proximity of the competitive calendar. The trunk does not exist in isolation from the rest of the athlete's programme; its development is constrained and enabled by the same bioenergetic and recovery mechanisms that govern all other training adaptations.

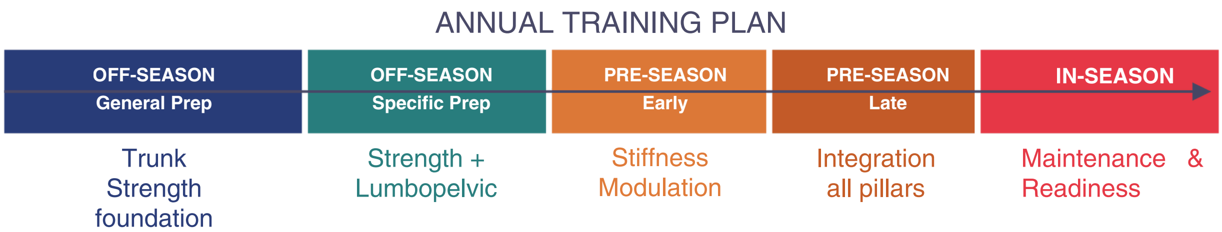

Figure 4. Trunk training periodization across the annual plan

Off-Season: Building the Foundation

The off-season is the appropriate period to develop the trunk strength base that all other qualities depend on. Progressive overload in loaded carries, bilateral and unilateral hip-dominant exercises, and anti-rotation work can be pursued without the constraint of competitive performance. Volume can be higher, intensities can be pushed, and the athlete can tolerate a greater degree of muscular soreness and fatigue without it compromising match or competition readiness.

Lumbopelvic control work during this phase should focus on establishing baseline coordination — sagittal, frontal, and transverse plane control in non-fatiguing conditions. This lays the coordinative foundation for the more demanding integrated and reactive training that will follow in later phases.

Pre-Season: Integrating Strength with Sport Demands

As the pre-season progresses and sport-specific training intensifies, the trunk training focus shifts from building capacity to integrating it. Stiffness modulation training becomes more prominent: medicine ball throw volumes increase, perturbation drills are incorporated into warm-up routines, and reactive balance and stability tasks are introduced in the context of sport-specific movement patterns.

Trunk strength work should be maintained in volume but the emphasis may shift toward exercises that more directly mirror sport mechanics — asymmetrical loading, rotational patterns, and single-leg variations that reflect the athlete's primary movement demands. The goal is progressive specificity: not abandoning the general strength base, but channelling it toward expressions that are directly relevant to competition.

In-Season: Maintenance and Readiness

In-season trunk training priorities are maintenance and injury resilience. Volume is typically reduced relative to the preparatory phases, but quality should be maintained. Two trunk-focused sessions per week — each of modest duration (15–25 minutes) — are generally sufficient to preserve the adaptations built in earlier phases.

The in-season is also the period in which lumbopelvic control becomes most critical. Fatigue accumulates over a competitive schedule, and fatigued athletes are more likely to exhibit degraded movement patterns in single-leg and rotational tasks. Maintaining a minimum volume of lumbopelvic control training throughout the season serves as insurance against this degradation.

Training Phase	Primary Pillar Focus	Volume / Intensity	Example Session Emphasis
Off-Season (General Prep)	Trunk Strength	High volume; progressive overload	Trap-bar DL, farmer's carry, Pallof press, anti-rotation progressions
Off-Season (Specific Prep)	Trunk Strength + Lumbopelvic Control	High volume; moderate intensity	Single-leg RDL, rotational cable, suitcase carry, dead bug progressions
Pre-Season (Early)	Stiffness Modulation + Trunk Strength	Moderate volume; higher velocity	Medicine ball throws, perturbation drills, loaded carry variations
Pre-Season (Late)	Integration (all three pillars)	Moderate volume; sport-specific velocity	Reactive perturbation, rotational landmine, single-leg anti-rotation
In-Season	Maintenance (all three pillars)	Low–moderate volume; maintain quality	2× weekly: 1 strength exercise, 1 stiffness drill, 1 lumbopelvic control

Weekly Micro-Structure

Within a weekly training micro-cycle, trunk training is most effectively distributed across multiple sessions rather than concentrated in dedicated 'core sessions'. Two to three brief trunk-focused sections per week — embedded in the warm-up, the supplementary section, or between primary training segments — provide sufficient stimulus for ongoing development without requiring dedicated session time.

The specific placement within the session should reflect fatigue sensitivity. Stiffness modulation and lumbopelvic control exercises, which are sensitive to neural fatigue and require precise motor control, are best performed early — in the warm-up or at the beginning of the supplementary section. Trunk strength exercises, which tolerate moderate fatigue better and benefit from the neural priming produced by the primary session, may be placed later in the session without significant quality loss.

CHAPTER 8

Sport-Specific Applications

While the three-pillar framework applies across sports, the relative weighting of each pillar varies with the primary mechanical demands of the sport. This chapter outlines how the framework is applied in several representative sport contexts. These are not prescriptive programmes — they are illustrations of how the same conceptual structure can be adapted to different mechanical environments.

Sprinting and Track Athletics

Sprinting is among the most demanding trunk tasks in sport. Ground contact times in maximal sprinting fall in the range of 80–100 milliseconds, during which the trunk must stiffen sufficiently to transmit ground reaction forces from the stance leg through the kinetic chain, resist the rotational torque generated by asymmetrical leg drive, and maintain the anterior pelvic tilt and thoracic extension that support hip flexor length-tension advantage in the swing phase.

For sprinters, stiffness modulation training is the highest priority pillar, given the speed, reactivity, and brevity of the trunk demand during ground contact. Trunk strength, particularly posterior-chain strength through hip-dominant exercises, provides the force production capacity that stiffness modulation draws upon. Lumbopelvic control — especially anterior pelvic tilt management and contralateral pelvic stability — directly influences sprinting mechanics and should be coached with specific reference to sprint posture.

Team Sports: Soccer, Rugby, Basketball

Team sport athletes face a qualitatively different trunk challenge from track athletes: the demands are multidirectional, unpredictable, and occur in the context of physical contact, cognitive load, and accumulated fatigue across extended match durations. All three pillars are highly relevant, but with different emphases depending on the sport.

In soccer, the most mechanically demanding trunk tasks are the kick and the change of direction. Kicking requires trunk rotation sequencing and contralateral lumbopelvic stability; change of direction requires rapid trunk stiffening during the deceleration phase and controlled pelvic positioning during re-acceleration. Rotational lumbopelvic control and stiffness modulation training are therefore primary, with trunk strength providing the robustness base for repeated exposure to contact and asymmetrical loading.

In rugby, physical contact — tackling, being tackled, scrummaging, mauling — imposes large, often sudden, tri-planar loads on the trunk. Trunk strength is the dominant priority in this context, with particular emphasis on load tolerance under asymmetrical and rotational perturbations. Perturbation-based stiffness modulation training is especially relevant for backs and loose forwards who experience high-speed contact scenarios.

In basketball, the trunk demands are concentrated around deceleration, change of direction, and shooting. The rapid stopping and re-starting characteristic of basketball — combined with overhead shooting mechanics — places significant demand on both frontal-plane lumbopelvic stability and sagittal-plane trunk stiffness during the deceleration–acceleration transition.

Throwing and Overhead Sports

Baseball pitching, tennis serving, and volleyball spiking all rely on the proximal-to-distal energy transfer mechanism described in Chapter 5. The separation angle between pelvis and thorax — and the speed at which the thorax subsequently accelerates to close that angle — is a primary determinant of upper extremity velocity. Training this mechanism requires systematic development of rotational lumbopelvic control, including both the production phase (driving pelvis-thorax separation) and the deceleration phase (controlling the follow-through).

Combat Sports

In wrestling, judo, mixed martial arts, and boxing, the trunk must simultaneously generate force, resist perturbation, and maintain positional awareness under conditions of maximal effort and unpredictable opponent forces. All three pillars are intensely demanded. Perturbation-based stiffness modulation training is perhaps most directly relevant here: the ability to produce rapid reactive trunk stiffness in response to unexpected forces is the most sport-transferable capacity that dedicated trunk training can develop for combat sport athletes.

Sport	Primary Pillar Priority	Key Trunk Demands	Training Emphasis
Sprinting / Track	Stiffness Mod. > Trunk Str. > Lumbopelvic	Ground contact stiffness; pelvic orientation; anti-rotation in swing	Reactive stiffness drills; hip-dominant lifts; sprint mechanics
Soccer	Lumbopelvic > Stiffness Mod. > Trunk Str.	Kicking rotation; COD stiffness; contact robustness	Rotational control; perturbation drills; loaded carries
Rugby	Trunk Str. > Stiffness Mod. > Lumbopelvic	Contact loading; tri-planar perturbation; repeated impacts	Heavy bilateral lifts; partner perturbation; asymmetric carries
Throwing / Overhead	Lumbopelvic > Trunk Str. > Stiffness Mod.	Pelvis-thorax separation; deceleration; thoracic mobility	Rotational cable; med ball throw series; thoracic mobility
Combat Sports	Stiffness Mod. > Trunk Str. > Lumbopelvic	Reactive stiffness; perturbation resistance; positional control	Band perturbations; heavy carries; anti-rotation isometrics

CHAPTER 9

Assessment Considerations

Assessment in trunk training serves two purposes: it informs exercise selection by identifying relative deficiencies across the three pillars, and it provides a baseline against which progress can be tracked over time. The goal is not to produce a precise quantitative score that determines training content — such an approach tends to overfit the programme to the test and underrepresent the complexity of real-world trunk demands. Instead, assessment should generate useful working hypotheses about where an athlete's current capacity is insufficient relative to the demands of their sport.

Assessing Trunk Strength

A practical approach to trunk strength assessment focuses on load tolerance relative to the athlete's body mass and sport demands. Isometric trunk endurance tests — the McGill Battery, comprising the lateral plank, trunk flexor endurance test, and Biering-Sørensen extension test — provide useful ratio-based comparisons that may indicate relative weaknesses in multi-plane strength. These tests have established normative data for athletic populations and are simple to administer in field settings.

The limitation of endurance-based tests is that they do not directly assess the force production capacity relevant to most athletic tasks. A stronger indicator of functional trunk strength may be the athlete's performance on loaded bilateral and unilateral exercises: the loads they can manage with appropriate technique on a split squat, a suitcase carry, or a single-leg RDL provide more sport-relevant information than a 90-second plank. Technique quality — assessed by a qualified coach — is as informative as load achieved.

Assessing Stiffness Modulation

Stiffness modulation is the hardest of the three pillars to assess reliably in field settings. Laboratory measures of trunk muscle activation timing (surface or fine-wire EMG), reactive balance performance (force platforms), and perturbation response latency are all used in research contexts but are impractical for most applied settings.

Practical field proxies include the athlete's landing mechanics during reactive jump tasks (does the trunk stiffen appropriately at contact or does it buckle?), their response to unexpected perturbations during unilateral stance tasks, and their ability to maintain alignment and performance on medicine ball throw tasks as velocity and complexity are increased. These are qualitative assessments, but when evaluated by an experienced coach they provide actionable information.

Assessing Lumbopelvic Control

Lumbopelvic control assessment is more straightforward, because the behaviours of interest — pelvic drop during single-leg stance, anterior tilt during hip-dominant loading, trunk rotation during unilateral tasks — are observable with the naked eye. A systematic movement screen that evaluates these patterns across sagittal, frontal, and transverse planes is sufficient for most practical purposes.

Useful assessment tasks include: single-leg squat with pelvic observation (frontal plane control), overhead reach with contralateral leg reach (rotational control and thoracic mobility), and split squat with pelvic position monitoring (sagittal plane control). The key is not to apply rigid pass/fail criteria to these tasks, but to use the observed patterns to guide exercise selection and coaching cues within the training programme.

Assessment should answer a practical question: which of the three pillars is most limiting this athlete's performance or resilience right now? The answer shapes emphasis, not prescription.

Monitoring Over Time

Periodic re-assessment — every 6–8 weeks in a continuous training programme, or at phase transitions in a periodised structure — allows the practitioner to evaluate whether the training emphasis has produced the intended changes. If trunk strength has improved but stiffness modulation quality has not, the programme emphasis should shift. If lumbopelvic control has improved in isolated tasks but not in more integrated contexts, the training should progress toward higher-complexity exercises.

CHAPTER 10

Myths, Misconceptions, and Marketing Claims

The trunk training space has attracted more than its share of fads, oversimplifications, and marketing-driven claims. This chapter addresses the most common ones directly — because clarity about what the evidence does and does not support is a prerequisite for rational programme design.

Myth 1: 'The Core Is the Foundation of All Movement'

This claim, often repeated in training culture, is not wrong in a loose sense but is practically misleading. The trunk is one important subsystem in athletic movement, and developing its capacity matters. But the claim that core strength is the primary determinant of athletic performance — implied in much marketing material — is not supported by the evidence. Lower-body power, technical skill, neuromuscular efficiency, and sport-specific experience are at least as important, and for most athletes represent greater sources of performance variance than trunk function in isolation.

Myth 2: 'You Should Always Brace Before Moving'

The advice to maximally brace the trunk before any movement is a simplified heuristic that may be useful in specific strength training contexts — maximal deadlifts, for example — but is inappropriate as a general movement principle. Sustained near-maximal bracing is metabolically costly, impairs breathing efficiency, and may actually reduce the capacity for the reactive stiffness changes described in Chapter 4. The nervous system of a well-trained athlete does not maximally brace before every movement; it generates precisely timed, appropriately scaled stiffness for each task.

Myth 3: 'Planks and Sit-Ups Are Core Training'

Plank variations and abdominal exercises are not inherently poor exercises. They develop isometric endurance in specific trunk positions and may serve useful purposes in early rehabilitation or as warm-up movement preparation tools. But the claim that they constitute a complete or primary trunk training strategy — particularly for athletes whose sport demands force production, rotational control, and reactive stiffness under load — is not supported. The spinal loads, muscle activation levels, and functional transfer produced by heavy loaded carries and hip-dominant exercises exceed what planks and sit-ups can provide (McGill, 2015).

Myth 4: 'Instability Training Improves Core Stability'

The use of unstable surfaces — BOSU balls, wobble boards, Swiss balls — became popular in the 2000s on the premise that they would enhance trunk stability by creating a more challenging environment for the neuromuscular system. Meta-analytic evidence has since shown that while instability training does increase trunk muscle activation in some contexts, it does so at the cost of substantially reduced force production — meaning the training stimulus for strength development is compromised (Behm & Colado, 2012). For athletes whose primary trunk demand involves high-force production in stable conditions, stable-surface training with progressive overload is considerably more effective.

Myth 5: 'Neutral Spine Is Always the Goal'

Coaching cues directed at maintaining 'neutral spine' during all exercises reflect a valid concern about spinal loading during heavy lifting but can be misapplied to suggest that spinal motion is inherently dangerous or undesirable in athletic contexts. This is not the case. Spinal flexion, extension, and rotation are normal components of athletic movement. The goal of trunk training is not to prevent spinal motion, but to develop the capacity to control motion across a range of positions and loading conditions — including end-range positions that occur naturally in sport.

> ***Good trunk training does not follow trends. It follows a coherent model of how the trunk functions in sport, progressed systematically, and adapted to the individual athlete's capacity and competitive context.***

On Proprietary Systems and Certifications

The trunk training field has generated a proliferation of proprietary assessment systems, certification programmes, and branded exercise methodologies, each claiming superior accuracy, transfer, or innovation. Practitioners should approach these offerings with appropriate scepticism. The core questions — what evidence supports the claims? what does the proposed method add over established, well-evidenced practice? what are the opportunity costs of adopting this system? — should be asked before committing time, resources, and athlete training hours to any specific branded framework. The three-pillar system presented in this guide is not branded or proprietary; it is an organising principle derived from a coherent and systematic practical application with athletes across different disciplines.

Closing Thoughts

The Omniathlete Trunk Training Framework is, at its core, an argument for conceptual clarity in a field that has often settled for slogans. The trunk is a complex, adaptive system. It is not a single structure, not a collection of muscles to be sequentially activated, and not a performance variable that can be optimised by any single exercise or certification. Developing it effectively requires a framework that respects its multi-dimensional function, integrates its training within the wider programme structure, and progresses it systematically in response to the athlete's evolving capacity and competitive demands.

The three pillars — Trunk Strength, Stiffness Modulation, and Lumbopelvic Control — are not the only way to organise trunk training. But they represent a more functionally honest and practically coherent framework than the alternatives that currently dominate training culture. They acknowledge the trunk's roles as a load-bearer, a force transmitter, an elastic spring, and a coordinator of segmental motion. And they connect exercise selection to the underlying mechanisms rather than to marketing claims or aesthetic outcomes.

The application of this framework will differ across sports, athletes, and practitioners. That is appropriate — and expected. A framework is not a recipe. It is a structure within which professional judgment, athlete feedback, and ongoing monitoring can operate to produce outcomes that no pre-specified programme could anticipate. The goal is not compliance with a framework but the development of a way of thinking about trunk function that will continue to generate useful solutions as contexts change.

Trunk training matters. Not because the 'core' is the foundation of all movement, but because the trunk's capacity to generate strength, modulate stiffness, and coordinate lumbopelvic motion is genuinely consequential for athletic performance and resilience. Developing that capacity coherently is the practical task this guide has tried to support.

For further resources, visit us at www.omni-athlete.com

About the Author

Antonio Robustelli is the founder of Omniathlete. He is an international high performance consultant and speaker in the areas of Sport Science, Strength and Conditioning, and Sports Medicine, with over two decades of experience working with individual athletes — including participation in five consecutive Olympic Games — and professional teams across soccer, basketball, rugby, and baseball. He currently serves as Faculty Member and Programme Leader at the National Institute of Sports in India (SAI-NSNIS).

His work is characterised by a systems-thinking approach to human performance, an emphasis on practitioner education, and a commitment to evidence-based practice that critically evaluates rather than uncritically adopts mainstream consensus.

Selected References

The following references informed the conceptual and empirical content of this guide. They are presented in alphabetical order by first author surname.

Behm, D.G. & Colado, J.C. (2012). The effectiveness of resistance training using unstable surfaces and devices for rehabilitation. International Journal of Sports Physical Therapy, 7(2), 226–241.

Hodges, P.W. & Richardson, C.A. (1997). Contraction of the abdominal muscles associated with movement of the lower limb. Physical Therapy, 77(2), 132–144.

Kelso, J.A.S. (1995). Dynamic Patterns: The Self-Organisation of Brain and Behaviour. MIT Press.

Kibler, W.B., Press, J., & Sciascia, A. (2006). The role of core stability in athletic function. Sports Medicine, 36(3), 189–198.

Leetun, D.T., Ireland, M.L., Willson, J.D., Ballantyne, B.T., & Davis, I.M. (2004). Core stability measures as risk factors for lower extremity injury in athletes. Medicine & Science in Sports & Exercise, 36(6), 926–934.

McGill, S.M. (2015). Back Mechanic: The Secrets to a Healthy Spine Your Doctor Isn't Telling You. Backfitpro Inc.

Panjabi, M.M. (1992). The stabilising system of the spine. Part I: Function, dysfunction, adaptation, and enhancement. Journal of Spinal Disorders, 5(4), 383–389.

Prieske, O., Muehlbauer, T., & Granacher, U. (2016). The role of trunk muscle strength for physical fitness and athletic performance in trained individuals: A systematic review and meta-analysis. Sports Medicine, 46(3), 401–419.

Vleeming, A., Schuenke, M.D., Danneels, L., & Willard, F.H. (2012). The functional coupling of the deep abdominal and paraspinal muscles: The effects of simulated paraspinal muscle contraction on force transfer to the middle and posterior layer of the thoracolumbar fascia. Journal of Anatomy, 221(6), 553–563.

Wirth, K., Hartmann, H., Mickel, C., Szilvas, E., Keiner, M., & Sander, A. (2017). Core stability in athletes: A critical analysis of current guidelines. Sports Medicine, 47(3), 401–414.