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NARRATIVE REVIEW ARTICLE

A conceptual review for optimizing physical wellness through balancing physical profile, nutrition, and recovery

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Abstract

Injury prevention in sports and active populations is often approached through isolated strategies targeting recent injuries or symptomatic areas. However, this narrow focus frequently overlooks the complex interplay of lifestyle factors. To address this gap, this conceptual review introduces the PNR Model, a practical framework integrating Physical Profile, Nutrition, and Recovery. Unlike existing approaches that treat these components separately, the PNR model provides an integrated, interactive framework that emphasizes systemic balance and body awareness. This review was developed through clinical physiotherapy observations and a selective review of peer-reviewed literature related to musculoskeletal health, exercise science, and recovery. This qualitative approach was chosen to conceptually outline the PNR model and its relevance to injury prevention and systemic well-being. Designed for clinicians, fitness professionals, and the general public, the model promotes a more comprehensive approach to injury prevention by highlighting often-overlooked contributors to musculoskeletal stress. Applicable across both in-person and telehealth contexts, the PNR triangle reflects the dynamic relationship between physical load, biological readiness, and systemic support. This review emphasizes the role of self-awareness, physical intelligence, and subjective monitoring in proactive, behavior-centered strategies. It also explores how PNR imbalances may impact broader health domains, including cardiovascular, immune, metabolic, and reproductive systems. Future research should assess its effectiveness in improving performance, preventing injury, and supporting overall health across diverse settings and populations.

Introduction

Many individuals invest in training programs, supplements, and wearables to increase training volume and intensity to reach their fitness goals. Despite moving more, eating better, or even sleeping longer, they may still encounter performance plateaus, recurring pain, or injury due to unmet physiological demands (Soligard et al., 2016). Unfortunately, they tend to overlook the fact that their body is consistently negotiating between multiple demands. Drawing from clinical physiotherapy experience, we observed a consistent pattern: Individuals who remain injury-free are not necessarily those who do more, but they listen to their bodies and align performance goals with recovery needs. From these insights, the PNR model was developed as a conceptual framework.

Individuals may struggle to translate these domains (Physical, Nutrition, and Recovery) into practical strategies that account for how the body negotiates multiple, often competing, physiological demands. Existing frameworks in literature and practice often treat and address these overlapping domains in isolation, overlooking how their integration influences performance longevity, fatigue, and injury risk. Consequently, despite significant advances in sports science and rehabilitation, a conceptual gap persists in understanding how these factors interact to maintain systemic balance. This indicates the clear need to address this gap and to unify a

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model that translates multidisciplinary knowledge into practical and adaptable strategies. Thus, the scope of the present conceptual review is to introduce the PNR model which uniquely integrates the key elements (Physical Profile, Nutrition, and Recovery) together in a cohesive and accessible framework that emphasizes body awareness and systemic balance, distinguishing it from existing approaches frameworks.

The purpose of this approach is to offer a fresh perspective by organizing these elements into a usable model that supports individuals, clinicians and practitioners in achieving sustained physiological harmony and support them in clinical reasoning and root-cause analysis, providing a foundation for future empirical and applied research, while also encouraging individuals to develop "physical intelligence" (PQ). PQ is defined as the ability to listen to and adapt to the body's signals (Wallman-Jones et al., 2021; PQ Initiative, 2025).

PNR model was developed and shaped by recurring clinical observations during physiotherapy practice, particularly among recreational and semi-professional athletes facing repeated injuries, fatigue, or performance stagnation. Alongside these real-world patterns, this review incorporates current scientific evidence to offer a multidisciplinary perspective on how the PNR components influence not only musculoskeletal health, but also broader systemic outcomes, hence, illustrating the dynamic interplay between these three interconnected elements.

Methods

This article presents a conceptual review based on clinical physiotherapy observations and a selective synthesis of relevant scientific peer-reviewed literature supporting the theoretical foundation of the PNR model. The search was performed mainly through PubMed, Google Scholar, and ScienceDirect, focusing on studies published between 2015 and 2025. Keywords included combinations of injury prevention, training load, exercise recovery, nutrition, systemic health, cardiovascular function, immune modulation, and reproductive health. Relevant sources were chosen based on their conceptual contribution to understanding the interaction between these domains rather than on strict inclusion criteria. This approach allowed the identification of consistent mechanistic and clinical patterns that align with the proposed model.

A systematic review methodology was not employed, as the aim of this paper was to develop and conceptually synthesize the PNR framework using clinical observations and representative evidence, rather than to comprehensively appraise or statistically evaluate all existing studies. Since no human or animal subjects were involved, ethical approval was not required. This work adheres to the principles of integrity, transparency, and responsible scholarship in accordance with the ethical standards of narrative review reporting.

Results

The outcome of this conceptual review is the development of the PNR model, referred to as the PNR Triangle (Figure 1). The model integrates and emphasizes the role of three key elements and their sub-classifications, Physical Profile, Nutrition, and Recovery, as interdependent components essential to preventing injury and promoting systemic physiological health in active individuals, while managing the dynamic tension between training stress, physiological capacity, and the body's need for restoration.

Physical Profile: The first component of the PNR model is the Physical Profile, which refers to individual's demands on the body that include biomechanical, neuromuscular, and structural characteristics, including joint mobility, muscular strength, posture, and movement patterns. This domain reflects the foundational physical readiness that influences training capacity and injury risk. Physical Profile covers Physical Activities, Activities of Daily Living (ADLs), Postural Habits, and History of Injuries or Surgeries.

Nutrition is viewed as a core pillar of the PNR model. Adequate nutritional input is emphasized for supporting cellular repair, hormonal function, and immune resilience during training and recovery cycles as it significantly influence injury prevention, recovery, gut health, and long-term performance. Nutrition covers food quality, hydration, and supplementation.

Recovery is a necessity in the PNR triangle as it keeps the other two elements functioning effectively. It is the

'silent investor' in fitness as it encompasses both physiological and psychological regeneration strategies. Evidence indicates that optimal recovery mitigates inflammation, supports adaptation, and prevents overtraining. Recovery covers sleep, prevention, and rehab.

Figure 1 illustrates the three pillars and their interconnected elements, where imbalances in one of these often result from not giving each aspect its proper attention.

Discussion

In clinical practice, the interplay between physical stress, nutritional support, and recovery strategies can be visualized as a triangular system. When all three are in harmony, your body becomes more resilient, performance improves, and the risk of developing injuries decreases (Bittencourt et al., 2017), even though injuries cannot be fully prevented (Stephenson et al., 2021). Imbalance in any component compromises overall function and increases injury risk. For example, training hard but neglecting sleep creates tension; eating well but moving too little causes imbalance; or sleeping well and working out with the best trainer without proper hydration leaves the body unable to keep up.

Physical Profile: The Demands Placed on the Body

Elements of the physical profile provide a comprehensive view of the body's physical journey and influence its ability to manage stress, adapt, and prevent recurrent injuries. Understanding this dynamic landscape is essential to prevent overload, promote adaptation, and tailor interventions that support long-term resilience.

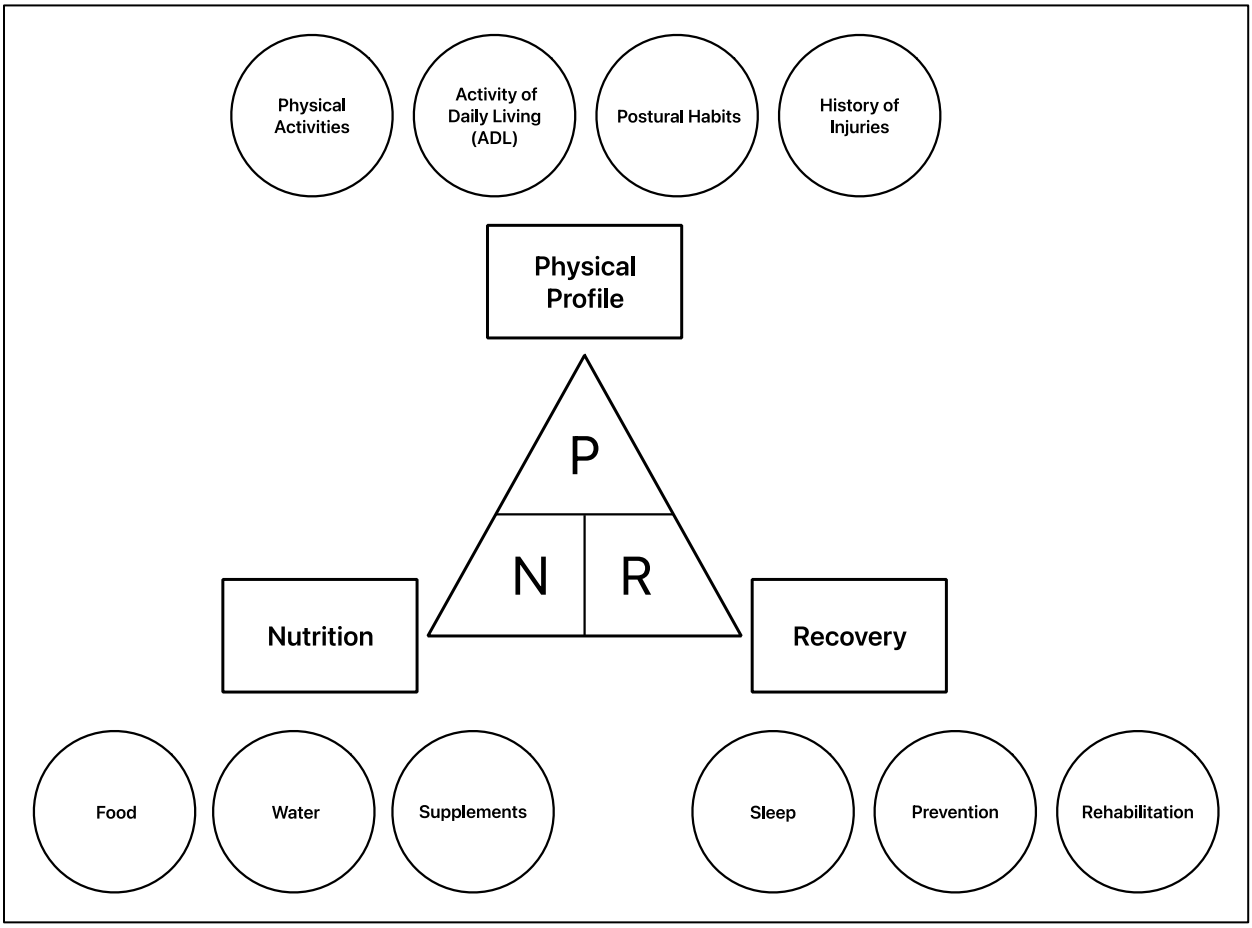

Figure 1. The three pillars and their interconnected elements.

Physical Activities

When people think about their physical activities, they consider their training program. However, what matters more than the activity itself is how often you do it (frequency) and how much your body can handle (Capacity). Some train six days a week with varied activities, while others train two to three times less intensely. Both approaches can be effective, but problems occur when training volume or frequency suddenly changes, creating a mismatch between load and the body's readiness.

Sometimes, a gradual increase in your training volume is needed, especially if you are introducing a new type of movement. For instance, you cannot move from playing basketball to long-distance running and expect your body to be at the same level of readiness. Your body needs to adapt to new loads to perform at peak level. This aligns with evidence showing that when acute workload significantly exceeds chronic load, the risk of injury rises sharply (Zouhal et al., 2021). Even weekend recreational activities like paddle tennis, hiking, or beach volleyball add to the total load. Based on clinical observation, when such activities are added without a corresponding increase in recovery, the body often compensates for approximately 4 to 6 weeks before compensatory patterns or signs of fatigue emerge.

While injury is one consequence of load mismanagement, the effects of exercise is systemic and extend beyond the musculoskeletal system. For example, excessive training may impair sperm quality by elevating testicular temperature, increasing oxidative stress, and disrupting hormonal balance (Hamim et al., 2025). In contrast, proper activity induces epigenetic changes regulating muscle adaptation and stress responses, enhancing immunity and lowering chronic disease risk (Widmann et al., 2019; Zheng et al., 2025). Thus, optimal exercise doesn't just improve performance, it "reprograms" the body at the molecular level, enhancing function and reducing the risk of disease.

ADLs

Outside the gym, ADLs impact the body as much as workouts, yet are often overlooked when assessing physical readiness and performance (Markova et al., 2024). Consider two individuals: one who sits for 10 hours daily and does long-distance cycling, and another who regularly performs site visits, climbs stairs, and does functional training three times a week. Although both are physically active, their daily movement profiles and injury risks differ significantly.

Ultimately, It's not just what you do but how much movement variety your body experiences daily. In other words, your training program should address the neglected movement patterns in your daily activities rather than repeatedly loading the same pattern. This is why addressing a broader range of movement, not just structured exercise, is essential for long-term physical health. In fact, impairments in ADL activities have been linked to declines in overall health, including mental well-being and reproductive function (Arayici et al., 2025; Li et al., 2025).

Postural Habits

Your posture is your body's default setting. It reveals how your muscles are loaded over time. Whether you are leaning toward one side while driving, crossing your leg during meetings, or lying on your side while scrolling through social media in bed, our body adapts to these movements and mold itself into them. These subtle habits accumulate, gradually shaping your structure. Poor postural habits can create tightness, weakness, and imbalances that eventually get exposed when the body is loaded. From a physical therapist's perspective, recurrent pain and injuries often stem not only from workouts but also from underlying postural habits. However, it is the physical activity that frequently brings these issues to the surface (Koźlenia & Kochan-Jacheć, 2024).

Beyond musculoskeletal concerns, sedentary postures may also compromise systemic health, contributing to lower heart rate variability (Fathima et al., 2024), elevated inflammation (Wu et al., 2025), and even poorer semen parameters in men with desk-based occupations (Wang et al., 2025).

History of Injuries or Surgeries

Old injuries, even "recovered" ones, leave lasting compensation patterns. A past ankle sprain might subtly affect your hip alignment (Yeum et al., 2024), and an old shoulder injury can impact how your spine is being loaded. Emerging research also suggests that previous tendon injuries may induce long-lasting epigenetic

changes that influence tissue remodeling, inflammation, and susceptibility to re-injury, offering a molecular basis for the body's compensatory patterns observed in physical therapy (Tarnowski et al., 2022).

Accordingly, analyzing the physical body journey through pain is essential from a rehab perspective. It helps identify weak links that might surface during physical stress. Ignoring these histories often leads to re-injury (Yousufy et al., 2023). Not because the person is training incorrectly, but because their body is compensating for unresolved patterns (Murata et al., 2025).

Nutrition: Fueling Function

Nutrition is a daily opportunity to either support or hinder your training progress. When viewed narrowly, through calorie-cutting, macro-tracking, or "eating clean", its broader role is often missed. When addressed intentionally, it gives the body what it needs to recover, adapt, and stay strong.

Food Quality

Your gut is more than just a digestion machine, and food is more than fuel. Food informs the body how to operate and regulate. Poor nutrition and processed foods can cause systemic inflammation, hormonal imbalances, and gut disruption, leading to effects such as reduced mental clarity, brain fog, low energy, joint pain, chronic fatigue, slower recovery, and even impaired reproductive function (Ciaffi et al., 2025; Zhang et al., 2025; Leisegang & Dutta, 2021). In contrast, having whole foods consistently can support your immune system, nervous system, enhance muscle repair, impact mental clarity, and improve gut health (Ciaffi et al., 2025). Food rich with micronutrients such as folate and vitamin B12 can influence gene expression supporting mental health, thereby playing a long-term role in overall physical and mental well-being (Bekdash et al., 2024).

Given that nutrition is a foundational pillar of overall health and function, it plays a vital role in injury prevention and recovery by supporting muscles and keeping the entire body in sync.

Water Intake

Hydration is often overlooked, with many considering drinking only when thirsty. By the time water losses exceed gains, the body is already experiencing the effects of dehydration, such as muscle tightness, reduced focus, and decreased performance (King, 2020). Additionally, fascia becomes less elastic, the digestive system struggles to operate efficiently, and recovery slows down (López-Torres et al., 2023). Dehydration also induces cardiovascular changes, impacting the heart and blood vessels by adjusting circulation to help conserve water (Dmitrieva et al., 2024).

Hydration isn't only about fulfilling thirst; it's more about maintaining the fluid dynamics of the body, cellular repair, temperature regulation, and waste elimination to avoid cramps and strains (López-Torres et al., 2023). Adequate water intake supports a healthy balance of gut microbiota and immune cells, particularly Th17 cells, thus strengthening the body's defenses against infections (Sato et al., 2024) .

Supplements

We're living in the era of "supplement gummification", a term we use here to describe the growing trend of turning vitamins into candy-like forms, where supplements look and taste like gummies, collagen is packaged as fruity jelly, and creatine comes in gummy bear form. At the same time, "biohacking" trends promise quick hacks for optimizing performance and health. These parallel trends reflect a growing demand for convenience and instant results in health and fitness.

On another note, some people have high expectations of their supplement, while others avoid them completely, thinking they are unnatural or unnecessary. Reality lies in the middle ground. Supplements should never replace food, but they can be incredibly helpful when used precisely.

From a health optimization perspective, it may be reasonable to begin with a blood test to help determine individual needs. Before consuming supplements, it's important to understand body's current status, what nutrients are deficient, which levels are borderline, and whether markers of inflammation are elevated. From there, supplements can be used strategically to fill nutritional gaps as they support overall performance when guided by data, not trends. This is especially important in today's era of well-being washing, a

phenomenon fueled by the booming wellness pop-culture (Khunji & Ebrahim, 2025).

Recovery: The Hidden Pillar of Fitness

If training breaks the muscle fibers, recovery builds them back stronger (Sousa et al., 2024). Yet, it's the most undervalued and overlooked performance tool. Many people push harder when they experience discomfort or mask pain with medications without asking if their recovery is supporting their physical output. By sleeping well, staying ahead of tightness, and responding to pain with the right approach, you can train consistently, stay out of the injury cycle as much as possible, and maintain an active and healthy lifestyle for years to come.

Sleep

Sleep is the most accessible, cost-free, effective recovery, foundational to nearly every body process. During deep, good sleep, body tissue repairs, hormones are regulated, and memory consolidation takes place (Hatia et al., 2024). Yet, despite all the benefits, sleep is the first thing we tend to sacrifice in the name of productivity. Poor sleep can slow down recovery, increase cortisol, affect mental clarity, elevate inflammation levels and may also extend to negatively influence male reproductive health by impacting semen quality (Charest & Grandner, 2022; Wang et al., 2025). Moreover, a recent mouse study showed that chronic sleep deprivation causes significant epigenetic changes that alter gene expression, resulting in disruptions across multiple tissues, including the heart, liver, kidney, lung, hippocampus, and spleen (Feng et al., 2024).

While the number of hours is important, it's just one variable of the sleep equation. What truly matters is the quality and depth of your sleep. There are two ways to assess sleep quality: the objective approach, using wearable devices, and a more affordable, subjective method, simply paying attention to how you feel when you wake up. If you feel fresh and energized, you are doing great, whereas if you feel tired and sluggish, most probably you would need to work on it.

Prevention

Preventive recovery needs proactiveness. It's the practice of responding to the body's whispers before they grow into dysfunction or pain. This calls for PQ, which is the skill of learning how to listen to your body and understand the signals it communicates to you. By observing the subtle signals, making sense of them, and responding accordingly (PQ Initiative, 2025; Wallman-Jones et al., 2021). Let's assume that every unpleasant sensation you experience is your body's way of speaking to you, just like the check engine light on your dashboard. Interoceptive sensitivity helps interpret what the body is saying (Wallman-Jones et al., 2021).

In the context of training, early signals such as tightness, fatigue, discomfort, or feeling sluggish when you wake up are worth paying attention to. When addressed promptly, these signs rarely progress into injury. Whether it's through soft tissue release (foam rolling, massage, dry needling), an ice bath, or contrast therapy to reduce inflammation and reset the nervous system, or sauna to enhance circulation and detox, each tool serves as an early intervention (Sousa et al., 2024).

Relying on clinical physiotherapy expertise, we highlight the preference for dry needling due to its precision in releasing and reactivating specific inhibited muscles (Cross & McMurray, 2017; Zarrin et al., 2023) in combination with ice baths to recalibrate the sympathetic nervous system (Espeland et al., 2022). However, these tools remain secondary to the underlying mindset as recovery should be integrated into the routine and not treated as an afterthought. Consider it as ongoing maintenance rather than emergency repair.

Rehab

When pain shows up, many people tend to resolve it with short-term fixes: painkillers, anti-inflammatory medications, or pushing through it, hoping it will resolve itself, but unfortunately, most likely it will get worse (Crofford, 2015). People with PQ don't ignore pain and address it promptly, knowing that delays can lead to prolonged recovery (Morgan et al., 2025).

Rehab isn't just for post-surgeries and major injuries. It's for the everyday aches and strains as well, which signals an imbalance (El-Tallawy et al., 2021). Effective rehab might mean identifying the root cause, not just rubbing the pain to treat symptoms (El-Tallawy et al., 2021). It includes a targeted warm-up protocol to enhance muscle fiber engagement and improve movement outcomes (Wilson et al., 2025). It can also be as

straightforward as creating a plan to transition from the injury phase back to training at full capacity.

When recovery is reactive rather than proactive, the risk of re-injury skyrockets. Effective rehabilitation acts as a form of long-term insurance, protecting your physical health over time. For example, a structured neuromuscular warm-up alone can reduce injury risk by as much as 60% in youth athletes (Lutz et al., 2024).

Managing the Tension between the Pillars

While the science behind performance and recovery is complex, translating it into practice requires careful attention to individual lifestyle habits and behavioral patterns. Clinical insights show that people approach fitness in varied ways, which can sometimes lead to imbalance. The following personas reflect common patterns that may disrupt the balance within the PNR model.

- The Overachiever: Trains six days a week and tracks macros obsessively, but sleeps 5 hours a night and skips recovery work. Result? Burnout, stiffness, and repeated injuries despite "doing everything right" (Brel et al., 2023).
- The Seated Athlete: Trains three times a week, eats relatively well, but he's seated most of his day at work, in the car, and at home. He doesn't move much outside of his workout. Result? Hip tightness, rounded shoulders, neck pain, and postural imbalances, which get worse with time (Meng et al., 2025).
- The Natural Mover: Moves around during the day, gets enough sleep, and eats intuitively, but lacks training structure and doesn't push physical abilities. Results? Low risk injury, but also low strength and missed physical potential.

These contrasting profiles highlight how imbalances across Physical Profile, Nutrition, and Recovery can manifest in different ways. To address these patterns effectively, the PNR model offers a practical diagnostic framework that is useful for both practitioners conducting assessments and individuals seeking to better understand and optimize their physical well-being. It helps organize behaviors, highlight blind spots, and guide sustainable decision-making. Understanding these imbalances is especially important when physical examination options are limited, such as during teleconsultations. In these cases, asking targeted questions becomes essential to uncover movement-related issues, recovery gaps, and nutritional imbalances, helping practitioners make informed decisions remotely (Saaei & Klappa, 2021). When signs of imbalance appear, it becomes important to review the element of the PNR triangle and undertake a thoughtful self-assessment by reflecting on the following questions:

- Do I wake up feeling refreshed or fatigued?
- Is my nutrition appropriately aligned with my current physical demands?
- Have I made any changes to my training routine within the last six weeks?
- Have there been any lifestyle changes in the past six months?

Everyone's "triangle" is unique. Building a personalized protocol that supports your lifestyle and goals mirrors the broader shift of healthcare toward precision and targeted medicine (Awwad, 2024).

Limitations

While the PNR model offers a structured approach to support physical well-being, several limitations should be acknowledged. First, this review is conceptual in nature and not based on a systematic literature search. Therefore, selection bias may be present in the evidence and examples cited, as they primarily stem from clinical physiotherapy experience and selectively reviewed literature. Second, although emerging research supports the components of the PNR framework, the model itself has not yet undergone empirical validation through longitudinal studies or randomized controlled trials. As such, its effectiveness as an intervention tool remains theoretical. Finally, while the model is designed to be practical and adaptable, its generalizability may vary across different populations, such as elite athletes, sedentary individuals, or those with chronic conditions.

Conclusion

This conceptual review introduced the PNR model as a practical framework designed to enhance body awareness, balance physiological demands, and support sustainable performance. The model emphasizes that injury prevention and progress are not about doing more, but

about doing better, listening to the body, respecting its limits, and aligning Physical Profile, Nutrition, and Recovery.

The PNR model redefines traditional views such as "no pain, no gain," highlighting that proactive recovery and adequate nutrition are integral to performance, adaptation, and overall well-being. Beyond musculoskeletal outcomes, this review underscores that physical stress, nutritional balance, and recovery habits can influence systemic functions including cardiovascular, immune, metabolic, and reproductive health.

Future research should evaluate the PNR model's effectiveness across varied settings and populations, as well as its broader relevance to systemic outcomes such as immune, metabolic, and reproductive health. In light of fertility trends reported in some populations (Mahasneh & Ebrahim, 2024), reproductive health may represent one promising area of exploration. Understanding how PNR-related factors affect these interconnected systems could enhance both clinical decision-making and individual well-being.

Author Contributions

All authors have made significant contributions to the conceptualization, methodology, writing (original draft preparation), review, and editing of this manuscript. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

All authors declare that there are no conflicts of interest.

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