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Personal Training Quarterly (PTQ) publishes basic educational information for Associate and Professional Members of the NSCA specifically focusing on personal trainers and training enthusiasts. As a quarterly publication, this journal's mission is to publish peer-reviewed articles that provide basic, practical information that is research-based and applicable to personal trainers.

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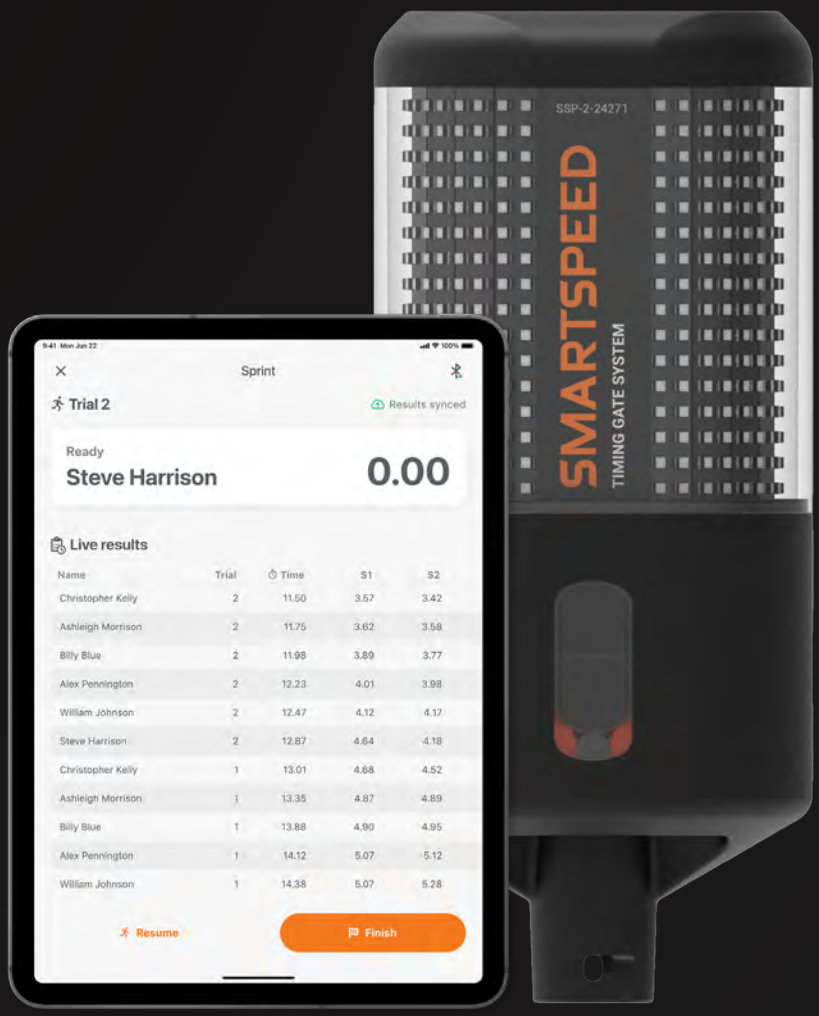

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WORKING AROUND A CLIENT'S LOW BACK PAIN—STRATEGIES AND EXERCISE PROGRESSIONS

NICHOLAS ROLNICK, DPT, MS, CSCS, AND JACOB TEMPLAR, DPT, OCS

Research has supported that the long-standing belief of resting during an acute bout of lower back pain (LBP) may worsen chances of recovery and increase the likelihood of chronicity (2,22,23,27). Given that LBP is one of the most common causes of disability worldwide, with around 75 – 80% of all individuals experiencing LBP at some point in their life, the likelihood is that most personal trainers will work with clients who have current or past histories of LBP (24). Awareness of the current published guidelines and beliefs surrounding LBP and exercise can assist the personal trainer in the decision-making process regarding exercise selection.

The focus of this article is to provide personal trainers with an evidence- and practice-based approach to exercise selection and implementation in those with LBP and to shed light on signs and symptoms that may warrant immediate referral to a medical provider. It is important for the personal trainer to be able to recognize signs and symptoms of potential pathology because personal trainers are considered one of the key professionals promoting physical activity to the public (30). Yet, only 20% of physicians report referral to a personal trainer due to fears of being poorly trained (30). The intent of this article is to help personal trainers become better educated on ways to work with clients with LBP and further, to understand when exercise is not appropriate. It is assumed that if a client is presenting with LBP that he or she has been seen by a medical provider and cleared for exercise. If a client presents with new onset of LBP, the personal trainer should use discretion to determine whether exercise without clearance from a medical provider is safe and within scope of practice.

LOW BACK PAIN LOCATION AND ITS ASSOCIATED PRESENTATIONS

LBP is defined by its location, typically between the lower rib margins and the buttock creases and is commonly accompanied by pain in one or both legs (24). In addition, some people with LBP have associated neurological symptoms in the lower limbs and posterior thighs, commonly known as sciatica (24). Sciatica is named for the sciatic nerve, which is the nerve that originates in the lower part of the low back and carries sensory and motor innervation to the posterior thigh and lower leg. When the sciatic nerve is impacted, neurological symptoms can range from numbness and pain down the back of the thigh and into the foot to potentially muscle weakness that impacts function (33). Research has shown that sciatica frequently presents with LBP up to 43% of the time with 50% recovering in 10 days and 75% improving in four weeks in one study, suggesting that sciatica itself is not a cause for stopping exercise (20,38). In fact, those with sciatica are recommended exercise and mobility training, necessitating the continued role of the personal trainer in the management of LBP (1).

RED FLAGS THAT WARRANT A REFERRAL TO A MEDICAL PROVIDER

Before proceeding further, the personal trainer should be aware of the signs and symptoms that accompany LBP that may suggest pathology. While the occurrence of pathology accompanying LBP is low, estimated around 1 – 4%, recognition of these symptoms may play an important role in early medical intervention (15,39). For brevity's sake, Table 1 covers major red flags and associated pathologies that may be underlying an individual's symptoms. The personal trainer is not trained to diagnose medical conditions, but this should not exclude understanding when to refer out. However, it must be said that despite the presence of these signs and symptoms, it does not guarantee pathology, only increases its likelihood and necessitates further medical examination to determine (10). It is important to recommend exercise clearance from a medical provider if a previously pain-free client presents with a new onset of LBP with any of these potential red flags or if these red flags present themselves in a client with current LBP.

DEFINING IRRITABILITY—A CRUCIAL CONCEPT IN EXERCISE PRESCRIPTION FOR LBP

"Irritability" is a term used to describe musculoskeletal disorders that focuses on the ability to negatively affect symptoms with an intervention ("movement" in the context of personal trainers) (31). It is a largely subjective measurement that considers the client's willingness to move, pain levels, and tolerance to exercise. It most often refers to the acuteness of the disorder, but all conditions (e.g., not just LBP) have the capacity to be irritable. The symptoms most relevant to personal trainers is pain but can also include numbness and tingling.

It is the job of the personal trainer to follow exercise recommendations from the medical provider. However, as LBP may present with varying levels of pain and functional impairments, personal trainers should make an honest attempt at assessing irritability before beginning an exercise program. As an unfavorable response may reduce exercise tolerance and lead to session cessation or even induce excessive pain or discomfort leading to an aversion to exercise, personal trainers should be aware of strategies that may increase adherence in clients with LBP.

Irritable conditions require some considerations given that there are emotional relationships to pain following the performance of aggravating movements that may be disproportionate relative to what would be typically expected (31). For example, in those with LBP, a 45-lb barbell deadlift exercise regimen may induce significant pain and movement loss despite the relatively low loads used, whereas in the same person who is now pain-free, they may be able to lift greater than 315 lb. In addition, the symptoms induced by the exercise may persist for 48 – 72 hr before returning back to a

baseline measure. Therefore, when working with those with LBP, it is advised to perform diligent tracking of exercise type and exercise volume as unaccustomed increases in either may predispose the irritable condition to temporarily (and unnecessarily) worsen.

The authors recommend attempting to classify irritability of LBP with a combined approach of subjective as well as objective measures. If there is any question regarding stratification of irritability in a client with LBP, reaching out to the client's medical provider is recommended before proceeding with exercise. Table 2 describes some common ways that irritability can be quickly assessed by the personal trainer. If the irritability is too severe, the client is having exaggerated responses to movement, or the client is physically or mentally unable to exercise secondary to fear of exacerbating existing symptoms, referral to a medical provider is warranted.

TABLE 1. SOME MAJOR RED FLAGS FOR LOWER BACK PAIN

POTENTIAL RED FLAGS	ASSOCIATED CONDITION
Age < 18 years old	Congenital abnormality
Age > 50 years old Long-term corticosteroid use Trauma (e.g., fall from over 3 ft)	Fracture
1. Genitourinary issues such as urinary retention or sexual dysfunction 2. Lower extremity muscle weakness 3. Saddle anesthesia (numbness or tingling around the genitals or anal region)	Cauda equina syndrome
Fever	Infection, malignancy
1. Unexplained weight loss 2. Progressive worsening of lower back pain without relief 3. Consistent night pain	Cancer

Information adapted from (9)

TABLE 2. CLASSIFYING IRRITABILITY IN A FITNESS CLIENT

LEVEL OF IRRITABILITY	POTENTIAL SYMPTOMS/RESPONSES TO MOVEMENT
Low	• Pain levels 0 – 3/10 • Able to tolerate moderate to heavy loading • Symptoms remain the same or slightly worsen during and/or following exercise but return to baseline within an hour • Client is minimally apprehensive to perform exercise
Moderate	• Pain levels 4 – 6/10 • Able to tolerate light to moderate loading • Symptoms increase during and/or following exercise but return to baseline within 24 hr • Client is moderately apprehensive to exercise due to fears of exacerbating symptoms
High	• Pain levels 7 – 10/10 • Able to tolerate very light loading/isometrics • Symptoms significantly worsen with any form of exercise and remain worse for more than 24 hr • Client is extremely apprehensive to exercise due to fears of exacerbating symptoms
	If present for more than one session, referral back to a medical provider is warranted

Adapted from multiple sources in conjunction with practice-based recommendations from the authors (14,19,34,36).

GENERALIZED FRAMEWORK TO PRESCRIBE EXERCISES BASED ON IRRITABILITY

When programming exercises for clients with LBP, a generalized framework can help with reducing the potential for adverse responses. As mentioned in Table 2, the highly irritable LBP client may benefit from a referral to a medical provider when it continues to present beyond one session. Otherwise, the moderate and low irritability LBP client has plenty of options that can be used to facilitate an active approach during a time when symptoms are present. In this section, the authors propose some evidence-based guidance for personal trainers working with clients with LBP.

Figure 1 depicts the many general modifications that personal trainers can use after classifying their client's stage of irritability. Note that there may be other strategies to assist in the different stages, including aerobic exercise and other forms of movement such as Pilates or yoga that may be beneficial for clients with LBP (7,25,40). The authors propose a traffic light system for resistance exercise inspired by peer-reviewed articles as well as the vast practical experience of the authors exercising with clients presenting with LBP (12,13,17,18,19).

The authors also propose that within these stages there are multiple exercises and movements that can be used to continue to safely work with clients. As personal training encompasses numerous potential avenues for resistance exercise, the authors decided to focus on the six most common patterns of movements that make up many resistance training programs (Table 3) (12,13,17,18,19,37). These normally include a horizontal row and press, vertical pull and press, squat, and hip hinge pattern (3,8,11). Along with providing the personal trainer with a rudimentary way to classify movement, these patterns also recruit most of the major muscle groups of the body.

Multi-joint exercises would target almost all muscle groups. Modifications can also be made to address isolated muscles depending on the stage of irritability. According to dynamic systems theory, if a client has a more difficult time with multi-joint movements, reducing the degrees of freedom by constraining the movement either by reducing total musculature (e.g., reducing it to a single-joint movement) or enhancing stability (e.g., moving to machine-based exercise) may allow for improved exercise performance within the movement pattern (5). Conversely, increasing the stabilization requirements and muscles involved in a movement pattern increases difficulty. Within our framework,

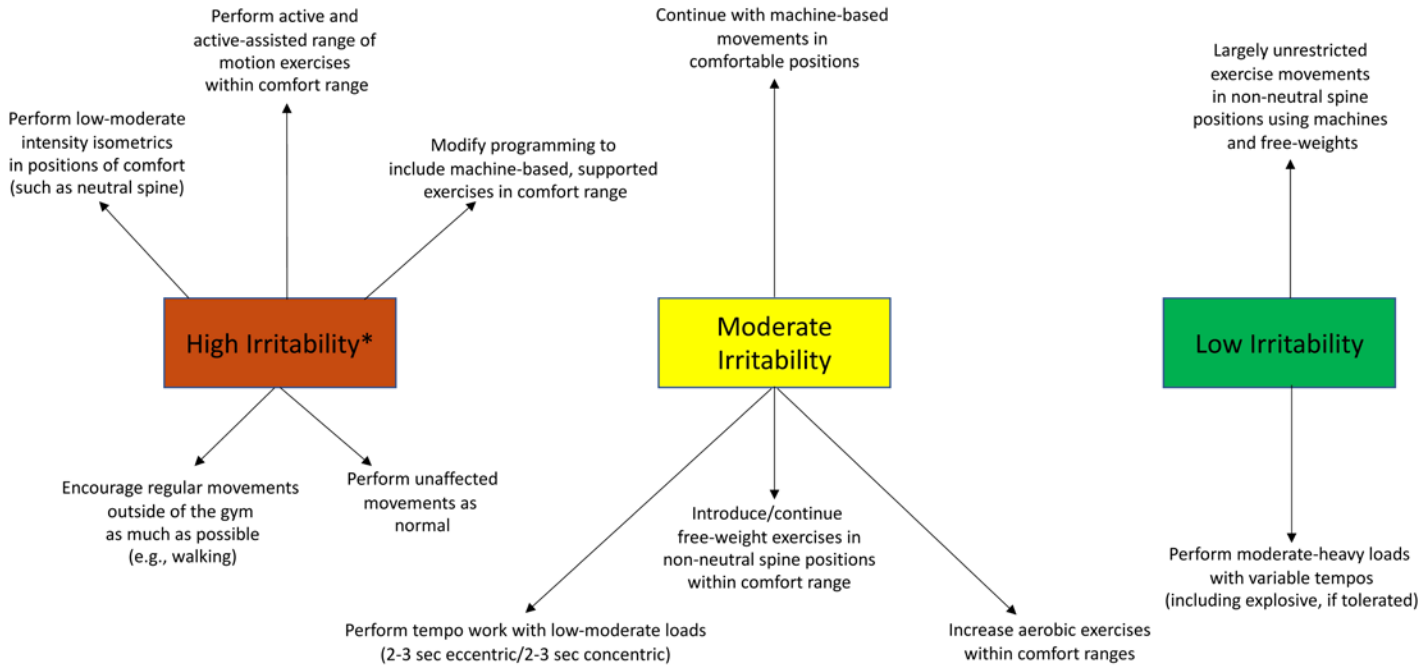

FIGURE 1. SUGGESTIONS FOR EXERCISE MODIFICATIONS THROUGHOUT EACH STAGE OF IRRITABILITY IN THOSE WITH LOWER BACK PAIN

enhancing stability or reducing the recruited muscle mass would be considered a regression and should be characterized accordingly compared to the pattern's more difficult movements with greater muscle mass or stabilization requirements. Based on the above rationale, the authors outline exercises from easiest to hardest.

For example, the bench press is considered a horizontal press movement pattern and recruits many muscles in addition to the pectoralis major, including the deltoids, triceps, and the forearms (28). In this framework, the barbell or dumbbell bench press is the hardest variation of this pattern due to the multiple muscles recruited and the stabilization required by the upper extremities to perform the movement. However, an easier variation would simply be recruitment of the pectoralis major (often considered the prime mover for the bench press) during a single-joint exercise, such as the machine chest fly. This regression reduces total muscle recruitment, increases stabilization because of the addition of the machine, and is in one movement plane. According to dynamic systems theory, this would be more accessible for the client than the bench press. In addition, the client with LBP can remain in a supported, seated position which may be more tolerable than getting into the supine position. The same rationale can be applied across the framework the authors present regarding difficulty levels across the various movement patterns.

While this is not a one-size-fits-all approach and does not include all the movements and exercises potentially available within a particular pattern, this can be a good starting point and template with most clients with LBP. This is particularly true since no form of resistance exercise has been shown to be largely superior to another in LBP (35). However, it appears posterior trunk and leg strengthening outperforms general exercise and walking programs in reductions in pain, disability, and improvements in strength (6). The authors chose this framework because it encompasses movement patterns that recruit the entire body in a categorical fashion, including the posterior trunk and thigh musculature (e.g., hinge) and can also be used in pain-free clients. This framework also allows the personal trainer to introduce harder and harder exercise variations with more freedom of movement (e.g., more stabilization requirements, force, or range of motion) as determined by the client's stage of irritability.

It is important to assess irritability prior to, during, immediately after, and 24 hr following the introduction of newer exercises, particularly when symptoms are present for two or more sessions within the same stage. The personal trainer may also consider reductions in training volume to more minimal levels then increasing intensity via manipulations of repetitions, sets, or load over sessions moving forward if the symptoms are manageable and excessive negative responses are not produced (26).

When new, more challenging exercises are introduced, (i.e., progressing from moderately difficult to hardest difficulty) it may also be wise to reduce training volume to further develop positive momentum back towards more "normal" training and to improve client confidence and comfort with movement. These recommendations align with the progressive overload principle and are in accordance with the National Strength and Conditioning Association (NSCA) recommendations for exercise prescription and progression as well as relevant published literature (4,21,29,32).

TABLE 3. EXERCISE SELECTION FOR THE SIX MAJOR MOVEMENT PATTERNS WITHIN THE THREE STAGES OF IRRITABILITY IN CLIENTS WITH LOW BACK PAIN

MOVEMENT	HARDEST DIFFICULTY	MODERATE DIFFICULTY	EASIEST DIFFICULTY
Horizontal Row	• Dead-stop barbell bent-over row • Barbell bent-over row	• One arm stabilized bent-over row • Seated cable row	• Chest-supported machine row • Prone supported dumbbell row
Horizontal Press	• Feet-hovering bench press • Barbell/ dumbbell bench press	• Counter/knee push-up • Machine press	• Machine pec flys • Wall push-ups
Vertical Pull	• Pull-ups/ weighted pull-ups • Single-arm pulldown	• Machine-assisted pull-ups • Cable pulldowns	• Prone shoulder extension • Cable chest-supported double- or single-arm lat pulldown
Vertical Press	• Overhead barbell press/push-press • Floor-seated dumbbell or barbell overhead press	• Seated barbell/dumbbell press • Seated pin-press	• Chest supported dumbbell/ cable lateral raises • Machine overhead press
Squat	• Low/high bar squat • Front squat	• Step up to box • Barbell/kettlebell box squat	• Leg extensions • Leg press
Hip Hinge	• Barbell deadlift • Barbell deficit deadlift	• Trap bar deadlift • Hip thrust	• Hip hinges • Supine double-leg bridges

**This table is constructed based on a hybrid of research as well as practical experience of the authors working with clients with low back pain.*

This article provides context to the personal trainer regarding the considerations needed when clients present with LBP as well as exercise modifications that could be used to help maximize exercise adherence. The personal trainer should not attempt to treat LBP but should recognize the current guidelines indicating exercise is a front-line approach to management of clients with LBP. In summary, personal trainers should recognize that LBP is relatively common in the general population and rarely indicates a serious condition. However, consultation or referral with a medical provider is warranted if symptoms interfere with exercise performance. This article provides a classification system of irritability based on prior research in other body regions that the personal trainer can use to design an exercise program in conjunction with the guidance of medical providers. Lastly, this article also includes a movement classification system that can be integrated not only in those with LBP, but in general training to help promote overall muscular development.

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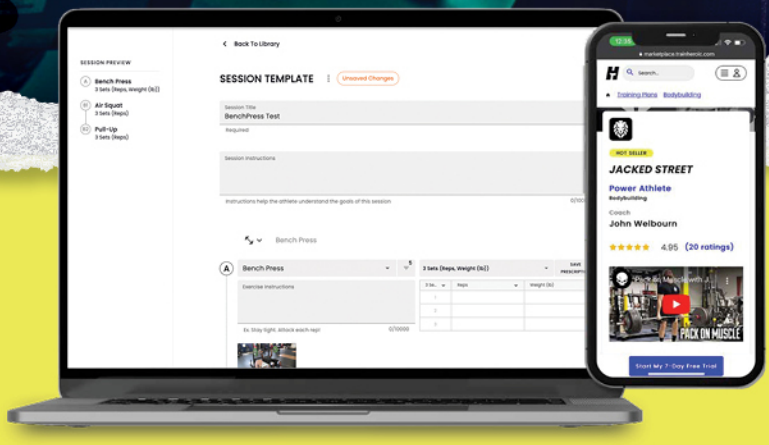

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PLANT-BASED NUTRITION FOR PERFORMANCE, RECOVERY, AND HEALTH

BROOKE STARKOFF, PHD, RDN, LDN, AND ELIZABETH LENZ, PHD

There are many reasons why individuals may embrace plant-based nutrition including improving health and athletic performance, protecting animal welfare, and reducing environmental impact. This article provides a background on the benefits of plant-based nutrition for athletic performance, recovery, and overall health.

When working with clients, it is important for personal trainers to understand where individuals fall on the spectrum of plant-based eating to help them understand how to achieve fitness and performance goals. While plant-based nutrition is not the only way to achieve peak fitness and performance, for many, reducing animal products and adding more legumes, fruits, and vegetables may be a great first step in improving performance and recovery. Although this article discusses nutrition and fitness, the scope of practice for personal trainers does not include the provision of specific or individualized dietary analysis or advice, or information regarding specific diets for athletic, general, and clinical populations. Collaboration between personal trainers and registered dietitians is recommended prior to major nutrition changes.

ORGANIZATIONS THAT SUPPORT PLANT-BASED NUTRITION

It is important to note that plant-based nutrition is supported by many national organizations including the Academy of Nutrition and Dietetics (7), National Kidney Foundation (24), American Institute for Cancer Research (29,38), and American Heart Association (21) and is recommended as a healthy dietary plan in the 2020 – 2025 Dietary Guidelines for Americans (36). Internationally, the EAT-Lancet Commission on Food, Planet, Health suggests "embracing plants as a source of protein" and going "easy on meat consumption," (37). Harvard's Healthy Eating Plate (14) and Health Canada (12) have also both shifted toward plant-based nutrition, minimizing the focus on animal-based proteins, and encouraging plant-based protein.

With many organizations promoting plant-based nutrition, it is essential to define what this diet entails (Table 1). Plant-based diets are void of animal-based foods, with a focus on whole, unrefined plants in the form of leafy green and other vegetables, legumes, fruits, and whole grains.

ROLE OF PROTEIN IN SPORT

In addition to multiple processes within the body, protein plays an important role in muscle growth and repair. Proteins originate from 20 different amino acids in the body, 11 of which can be created by the body (non-essential) while the remaining nine (essential) must be consumed in the diet. Once in the body, proteins can be used directly or broken down into amino acids, repackaged, and circulated to the necessary tissues. To encourage muscle protein synthesis—the biological process of building new protein cells to rebuild and repair muscle tissue, via amino acids—specific amino acids must be available within the body stores. The amino acids that are needed either originate from plants or are created within the body from other amino acids. For meat-eaters, individual amino acids from the meat source are from amino acids within the animal, many of which can be traced back to the plants the animal consumed. Protein consumption is an important component of recovery, as the body responds to the stress of exercise, including muscle breakdown. Identifying the appropriate amount and type of protein to consume prior to and following exercise is essential for skeletal muscle synthesis.

HOW MUCH PROTEIN SHOULD BE CONSUMED?

Clients participating in strength activities should aim for 1.4 - 2.0 g of protein per kg of body weight. The range accounts for the extent of damage based on the variation in activities (17). Bodybuilders, for example, who undergo significant muscle damage require greater amounts of protein when compared to endurance athletes who typically strive to preserve lean body mass. Despite these recommendations for protein intake, some clients consume substantially greater quantities. Research examining perceived protein intake of male athletes found that one in five believed recommended intake was 4 g/kg/day or greater (10), yet a recent meta-analysis found 1.5 g/kg/d with concurrent resistance training to be the most appropriate for improving muscle strength (34).

PLANT VERSUS ANIMAL PROTEIN

Many clients interested in plant-based nutrition are unsure if plant-proteins are adequate for their performance and recovery needs. Although the essential amino acid content of plant and animal-based proteins differ significantly, consuming a variety of plant-based sources provides an ample amount of protein for most individuals (5,22,23). While some plant-based foods may be low in certain essential amino acids, eating a variety of foods that contain greater amounts of that same amino acid, make up for the deficit (23). For example, consuming foods with low lysine content, such as grains, with foods higher in lysine (e.g., legumes) throughout the day, will allow individuals to achieve recommended daily amino acid consumption. Subsequently, the amount of specific amino acids required for clients can be achieved simply by consuming a greater variety and quantity of plant-based foods (23,26).

DIGESTIBILITY OF PROTEIN

Some clients may have concerns over the lower rates of digestibility of plant-based proteins compared to animal-based sources. Subsequently, vegan athletes have been counseled to consume approximately 10 – 22 g more protein than omnivores (5). However, newer methods of assessing protein quality have found only a small difference in digestibility between animal and plant-based protein (22). Researchers recognize that consuming

the same amount of protein from plant-based sources as one would from an omnivorous diet may require an unrealistic and substantially larger amount of some foods. However, for most clients, combining a variety of plant foods throughout the day could create a more balanced amino acid profile, reducing the volume of food required to meet client needs (26). A study comparing omnivorous athletes to those following a plant-based diet found no significant difference in muscle protein synthesis between groups (15). In fact, plant-based foods have been shown to foster an environment to support post-exercise muscle protein rebuilding (5).

The greater concern regarding animal-based proteins may be the additional components within the foods. For instance, saturated fat and cholesterol are significantly higher in animal-based proteins compared to most plant-based foods, potentially increasing the risk for disease conditions (3,4,35). Conversely, plant-foods provide little to no fat or cholesterol and contain additional nutrients including phytochemicals and fiber. The reduced risk of atherogenesis from reducing cholesterol and saturated fat in the diet, combined with the influx of antioxidants and phytochemicals from plant-based sources to combat reactive oxygen species, may be a contributor to improved performance and recovery. It is worth mentioning that with the current agricultural industry utilizing herbicides, pesticides, and genetically modified organisms, few non-organic foods come without risk. Yet, these are the same sources consumed by many animals that humans then consume. Thus, a well-planned plant-based diet does not significantly contribute to detriment in health or performance.

PERFORMANCE AND RECOVERY

Blood flow affects both athletic performance and recovery. Animal protein has been linked to the genesis of heart disease, contributing to poor blood vessel compliance and oxygenated blood flow (35). Conversely, increased fruit and vegetable consumption can reduce the onset and progression of vascular injury (3,35). Beet roots and leafy greens, for example, contain nitrates which, when converted to nitric oxide, increase vasodilation (18). Subsequently, plant-based nutrition may promote blood flow and aid in oxygen delivery and metabolic waste removal (2). The result is greater blood flow to the working skeletal muscle, potentially improving endurance and transient hypertrophy. In terms of recovery, enhanced blood flow may also translate into improved lactate clearance, permitting faster recovery, particularly between multiple bouts of exercise.

Additional benefits include the reduction of oxidative stress and inflammation. Muscles produce reactive oxygen species during exercise, which can damage DNA and other proteins, resulting in reduced performance and recovery (28). Consuming foods rich in antioxidants can slow or prevent oxidation and inflammation, allowing clients to delay fatigue (2). Since plant-based foods contain significant amounts of antioxidants, individuals following plant-based nutrition have shown better antioxidant activity compared to omnivores (6). Therefore, compared to an omnivorous diet, plant-based nutrition may better reduce inflammation, improving performance and recovery.

HEALTH BENEFITS OF PLANT-BASED NUTRITION FOR CLIENTS

There is often an assumption that physical activity ameliorates many disease risk factors. While research supports the health benefits of physical activity, it is important to not ignore the significant role of diet on health. Recent reviews have suggested athletic individuals are not immune from the development of atherosclerosis (1,3). Of all the contributors to atherosclerosis in active people, diet may be the most modifiable. By implementing plant-based nutrition, clients may notice a positive impact on other mechanisms of atherosclerosis, such as reduced inflammation and systolic blood pressure, lowered low-density lipoproteins and total cholesterol, and improved high density lipoproteins (3,9,39).

Additionally, plant-based nutrition may contribute to reduced body fat, which may be advantageous for those clients interested in total fat loss. Independent of weight loss, incorporating plant-based nutrition can reduce body fat percentage, particularly in those who are overfat (3). There are several factors that promote healthy body composition from consuming plant-based foods, including higher fiber intake, reduced caloric intake, and increased energy expenditure. Plant-based foods contain considerable amounts of fiber, which not only improves gut microbiota, heart health, and colon health, but also induces satiety and contributes to reduced caloric intake (3,8). Plant-based diets also contribute to increased mitochondrial number and activity, resulting in elevated fat metabolism as well as increased energy expenditure following meals (27). Combined, these mechanisms can assist in helping clients achieve a healthy body fat percentage and may ultimately aid in improved fitness.

OVERCOMING PERCEIVED BARRIERS TO PLANT-BASED SPORTS NUTRITION

ENERGY BALANCE

Consuming enough calories to maintain energy balance and ward off relative energy deficiency in sport (RED-S) is critical when moving away from a meat-centered diet. Aside from the lower caloric content compared to animal-based products, plant-based foods are often higher in fiber, contributing to earlier feelings of satiety (3). To combat this issue, clients at risk for RED-S should consume more energy-dense plant-based sources (e.g., nuts, avocados) and eat additional snacks throughout the day. Liquid calories from smoothies and soups may also help clients achieve optimal caloric intake.

NUTRIENTS OF CONCERN

There is an assumption that clients who consume little to no animal products fall short on meeting nutrient requirements necessary for performance (26,30). This is an area that is challenging to examine due to variations in diets, but studies examining nutrient intake among vegetarian and vegan athletes show a trend that many are meeting, and occasionally

exceeding, recommendations (25). Vitamins and minerals crucial for performance, such as iron, calcium, and B vitamins are also present in plant-based foods and may provide greater benefit from plant-based sources compared to animal proteins. Yet the concern of deficiencies is valid for all active individuals, not just those removing animal products from their diet. The following section will outline important micronutrients that aid in performance and recovery and ways to ensure clients meet these recommendations from plant-based sources (Tables 2 and 3).

CALCIUM

Traditional recommendations for calcium include consuming three servings of dairy daily. Yet some research has identified reduced calcium bioavailability from dairy compared to plant-based sources, with higher rates of absorption from beans and greens (40 – 64%) compared to milk (25 – 32%) (19). Additionally, calcium absorption decreases with increased calcium load specifically from dairy products, highlighting a detrimental impact of excess dairy consumption (19,33). Plant-based sources of calcium, including leafy greens and legumes, may be a better alternative to dairy.

IRON

Although commonly associated with animal products, iron is also found in plant sources such as legumes, seeds, grains, and fortified breads and cereals. Heme iron, found in animal products, is better absorbed, however, non-heme iron from plant foods should not be deemed inferior. In fact, excess heme iron consumption contributes to DNA damage and has been linked to the development of chronic diseases (11,13,16,32). Conversely, non-heme iron was inversely associated with breast cancer risk, demonstrating a benefit to non-heme iron sources (31).

VITAMIN B

Since B12 is produced by bacteria and then consumed by and stored in animals, there are limited plant-based sources of this vitamin other than nutritional yeast, fortified cereals, nori, and Mankai. Subsequently, B12 supplementation is recommended for those following a plant-based lifestyle.

VITAMIN D

Current recommendations are to obtain vitamin D from sunlight and to consume fortified foods such as cereals, soy/almond/oat milk, or juices (23). Due to multiple factors contributing to vitamin D deficiency, vitamin D supplementation is recommended for any individuals at risk for deficiency.

REIMAGINING MEALS

For many active Americans, a meal is likely to consist of a piece of meat, a side of grain, and potentially a side of vegetables. However, when adopting a plant-based lifestyle, meals may look different. Oftentimes, plant-based meals may be a bowl of grains and legumes, filled with leafy greens, cruciferous vegetables, and a sauce. Although it may take some time to change the composition of the client's meals, encourage small changes such as beginning by updating one meal per week, or even one per day (Tables 2 and 3).

As the plant-based movement gains momentum, many companies are responding by creating meat replacements (e.g., plant-based burgers, sausages). Although these items may be lower in saturated fat and cholesterol than meat, it is the actual plants that provide significant health benefits. If meat-replacement items are helpful in the transition to plant-based eating, consider adding whole foods (e.g., lettuce, tomato, avocado) to incorporate more of those nutrients. The focus should be on the fiber and phytonutrients in natural plant-based foods.

THE BEST DIET FOR PERFORMANCE AND RECOVERY IS CONTENTIOUS

There are myriad nutrition plans that clients may want to participate in for various reasons. Including the standard American diet, all nutrition plans should be well-planned and well-researched. Current studies have demonstrated that plant-based diets show promise in terms of aiding in performance and recovery without detriment. Due to the novel research on plant-based eating with regular exercise, there are few articles comparing the impact of omnivorous to plant-based diets on performance and recovery. Muddying the waters even further is a lack of consistency in training protocols and quality of diet in the research. The authors acknowledge these limitations but believe the recent reviews of the literature highlight that plant-based nutrition does not negatively impact performance or recovery but can be more beneficial to health and well-being (26).

As there is recent increased interest in and a trend toward consuming more plant-based foods, it is important for personal trainers to recognize the impact of plant-based nutrition on fitness, performance, and health. Although personal trainers should not provide specific nutrition counseling, understanding the impact of plant-based nutrition on performance and health is beneficial in reassuring clients and debunking common myths. Additionally, instead of focusing solely on how protein can increase muscle mass, it may be useful to view the client as a whole person and understand the impact of the additional benefits to consuming more plant-based foods (e.g., reduced disease risk, improved vasodilation). Depending on wherever your clients fall on the plant-based spectrum, moving toward a whole food plant-based lifestyle may be an appropriate method to achieve their goals.

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TABLE 1. DEFINITIONS OF DIFFERENT DIETS (7,34)

DIET	KEY COMPONENTS
Plant-Based	• Eating whole, unrefined plants in the form of greens, vegetables, legumes, fruits, whole grains, omega-3 rich seeds, spices, and naturally unsweetened beverages • Avoiding meat, dairy, eggs, sweetened beverages, and plant fragments • No limits on quantity (judge by fullness)
Whole-Food Plant-Based, No Oil	• Strictest form • Plant-based diet that avoids plant fragments, such as oils and processed foods
Vegan	• Eliminate all animal foods from diet (e.g., meat, fish, seafood, poultry, eggs, dairy, and honey)
Vegetarian	• Excludes most animal foods from diet but some people may eat dairy products, fish, or eggs • Mostly plant-based • There are different variations of the vegetarian diets such as pescatarian (includes seafood), lacto-vegetarian (includes dairy, not eggs), lacto-ovo vegetarian (includes eggs and dairy), and ovo-vegetarian (includes eggs, not dairy)
Omnivore	• Eating animal- and plant-based foods

TABLE 2. TIPS FOR STARTING A PLANT-BASED DIET

- Replace dairy products with almond, coconut, rice, oat, flax, and cashew milk products.
- Replace meat-based meals with beans. Make tacos with black and pinto beans, make sloppy joes with lentils, and add beans to salads.
- Begin by substituting one plant- based meal or snack each day.
- Prepare fruits and vegetables and place them on the counter or in the front of the refrigerator for easy access.
- Incorporate frozen or canned fruits and vegetables into meals.
- Incorporate protein-rich plant foods into meals (e.g., grains, legumes, soy foods, nuts, and seeds; lower fat options include peas, beans, and lentils).
- Add vegan protein powders (based on pea, rice, seeds, or soy) to smoothies.
- Add foods high in vitamin C (e.g., strawberries, citrus fruits, bell peppers) to improve the absorption of non-heme iron from plant sources.
- Soak, ferment, and sprout foods to break down oxalates, phytates, and polyphenols that naturally inhibit calcium and iron absorption.

TABLE 3. SAMPLE MEALS

To achieve a post-exercise protein intake of 20 – 25 g, consider the following options (grams of protein in parentheses):

Breakfast:

- 1 cup tofu scrambled (20 g) with ½ cup mushrooms (1 g), 3 cup spinach (3 g), and 1 cup berries (1 g)
- Bagel (9 g), 2 tbsp natural peanut butter (8 g), and banana (1 g), 1 tbsp flax seed (2 g)

Lunch:

- ½ cup hummus (8 g), 3 cup arugula (2 g), 1 cup sliced tomatoes and cucumbers (2 g), ½ cup sliced beets (1 g), in pita (6 g) with an apple (1 g)
- ½ cup celery, 1/2 cup kidney beans (8 g), ½ cup cannellini beans (8 g), ½ cup parsley, tossed in rice vinegar and lemon juice

Dinner:

- 1 cup quinoa (8 g) stir fried with 1 cup bok choy (1 g), 1 cup mushrooms, carrots, purple cabbage (3 g), and ½ cup edamame (9 g)
- Lentil tacos: 1 cup lentils (18 g), ½ cup diced tomatoes and chopped lettuce (1 g), taco shell (1 g), ½ cup avocado (1 g)

Snacks:

- Tofu smoothie: 6 oz silken tofu (8 g), ⅔ cup soy milk (6 g), 1 cup spinach (1 g), 1 banana (1 g), 1 cup frozen blueberries (1 g), 1 tbsp natural peanut butter (4 g)
- Trail mix: 2 oz peanuts (14 g), ¼ cup raisins (1 g), 1 tbsp vegan chocolate chips (1 g), 1 oz pumpkin seeds (5 g)

HOW TO MANIPULATE REST INTERVALS TO MAXIMIZE STRENGTH TRAINING EFFECTIVENESS

AJ MORTARA, EDD, CSCS,*D

The typical personal training session lasts one hour, including warm-up and cool-down. Some clients have even less training time due to travel, wardrobe changes needed for work, etc. Therefore, personal trainers must be efficient, accomplishing as much work as possible, in a narrow, often sub-optimal time window.

A common strategy is to increase training density (minutes of work divided by total minutes in a session) by decreasing rest intervals between sets. However, this may not always be the best strategy. In fact, numerous articles have been published indicating that longer rest periods between resistance exercise sets may produce better strength and hypertrophy outcomes (3,4,7). This article will review the latest evidence regarding optimal rest intervals, and the science behind them. Alternative time saving strategies will also be examined.

IS 60 SECONDS OR LESS REST BETWEEN SETS GOOD?

Exactly how long a client needs to rest between sets is dependent upon numerous factors. Some of these factors include age, the type and intensity of the exercise performed, the total accumulated fatigue of the client, and a client's training experience.

Perhaps the most crucial factor in determining rest interval length is the type and intensity of the exercise performed. Core movements, which recruit large amounts of muscle mass, such as squats or deadlifts, require longer rest intervals. Research literature suggests a minimum of two minutes or more between sets, with as long as five minutes being acceptable (3,6,7). For accessory, or single joint, movements, such as biceps curls or calf raises, rest periods of 1 – 2 min are likely sufficient for most populations.

HOW SLEEP AND STRESS SHOULD IMPACT REST INTERVALS

The second most critical factor is the total accumulated fatigue of the client. This is a difficult factor to quantify and largely out of the hands as the personal trainer. Factors which contribute to cumulative fatigue are sleep, stress, and diet. It is well known that sleep quality and quantity impact exercise performance (1). Therefore, on days when clients are exhausted from poor sleep quality, an increase in rest interval is warranted; a decrease in training volume and intensity may also be necessary. Stress also plays a major role in exercise performance (9).

Many clients live busy, stressful lives, which is often reflected in the gym. For example, training loads and volumes that were manageable last week, can become exhausting or even impossible this week due to stress from work or home. It is the personal trainer's job to observe and react accordingly by lengthening rest intervals and potentially altering the session plan.

NUTRITION AND REST INTERVALS

The impact of diet on exercise cannot ignored. Most training clients have a weight loss goal and employ calorie restrictions, even on training days. This is an important consideration when determining rest intervals. Diet counseling with clients is beyond the scope of this article; however, if clients are on a steep calorie deficit, they may benefit from longer rest intervals between sets. This is especially true if they are on a low carbohydrate diet, which will impair both performance and recoverability (10).

It is important to note that all of the above factors and their impacts are subjective. Determining how long the rest interval should be for a given session will be a combination of client self-reporting and the personal trainer's observations during the warm-up and initial exercises.

TRAINING AGE AND REST INTERVALS

Another factor, which complicates the discussion, is the experience level of the client, often referred to as "training age." Training age can impact rest intervals in a variety of ways. Clients with a low training age (i.e., beginners) are usually not able to safely sustain high training loads. Therefore, their programs tend to utilize more accessory movements, have fewer multi-joint lifting movements, and are performed at a lower intensity.

These programs can take the form of circuit training and involve very low rest intervals (about 30 s) (6). As a client develops and shifts towards hypertrophy and strength programs, their work capacity increases, as well as their fatigue tolerance. This leads to more multi-joint lifting movements, heavier loads, and longer rest periods (2 – 5 min). A personal trainer will have to use their judgement to determine when these shifts can occur within the greater framework of the clients' program.

ADJUSTING REST INTERVALS EACH SESSION

With so many factors impacting rest interval length, it becomes clear that a client-to-client and session-to-session approach is best. Adjusting programming on a session-to-session basis, based on performance, or perceived capacity is termed "autoregulation" (3). This can be accomplished in a variety of ways, using both quantitative (e.g., monitoring heart rate) and qualitative data, (e.g., using rating of perceived exertion [RPE] or repetitions in reserve scales). The goal is to tailor microcycles and mesocycles to client abilities by balancing fatigue and performance. Autoregulation is a far-reaching concept that applies to training volume, intensity, rest intervals, and exercise selection.

Applying autoregulatory principles to rest interval length involves assessing a client's fatigue level and lengthening or shortening the interval accordingly. There are a few fatigue factors to consider: cardiovascular, local muscle, and mental fatigue. Unless a client has a specific cardiovascular goal that is being met

during resistance training, high heart and breathing rates are not beneficial, and will negatively impact future set performance. Poorly trained clients will likely require additional rest time to allow for cardiovascular recovery. Monitoring heart rate during sessions can help quantify these needs, but subjective report from the client is also satisfactory. Rest intervals greater than three minutes are likely required.

MUSCULAR FATIGUE AND REST INTERVALS

It may seem obvious, but local muscle fatigue can also negatively impact successive set performance. As a result, rest intervals often need to be lengthened on successive sets to ensure full recovery; for example, a two-minute rest after the first set, three minutes after the second and so on. This is not limited to the agonist muscles only, synergists and stabilizing muscles must recover fully prior to successive sets.

In addition to muscular fatigue, mental fatigue will also limit performance. In essence, if a client does not "feel ready," regardless of their physical readiness (e.g., muscle soreness), additional rest is required. Mental preparedness allows for a greater focus on movement technique and muscle contraction; this is referred to as the "mind muscle connection" and has been shown to improve exercise performance and adaptations (8). Therefore, the ideal recovery interval is long enough to substantially decrease heart rate, eliminate local muscle fatigue, and restore mental focus.

HOW TO USE AUTOREGULATION FOR REST INTERVALS

While research on autoregulation does not suggest a specific minimum or maximum rest interval, it is important to balance the need for rest, with training density and client time constraints. A reasonable strategy is to assign rest interval lengths within the 2 – 5 min range established by research, and then autoregulate within that range.

USING SUPERSETS AND DROP SETS

If time constraints still inhibit a client's ability to complete their program, other time saving strategies, such as supersets and drop sets, can be employed to maximize efficiency. Supersetting involves performing two exercises back-to-back with no rest between them (5). A common strategy includes pairing agonist and antagonist movements such as a chest movement followed by an upper back movement or a quadriceps movement followed by a hamstring movement. Table 1 shows a sample total body superset program.

Another common time-saving strategy is drop set training. Drop set training involves performing multiple sets of an exercise, reducing the load on each successive set with no rest interval between them (5). For example, a client may squat 225 lb for their first set, 185 lb for their second, and 135 lb for their final set. Obviously, fatigue will be high, and therefore a long rest interval may be needed upon completion. Load reductions will vary based on client tolerance and total volume per muscle group, however, researchers have recommended 20 – 25% (5).

Evidence suggests that both supersetting and drop setting are effective at developing muscular hypertrophy and strength (5). However, it is unclear if they are as effective as traditional straight sets. Ultimately, it is likely a tradeoff: training more muscle groups with less volume per muscle versus training fewer muscle groups with additional volume per muscle.

TABLE 1. SAMPLE TOTAL BODY SUPER SET PROGRAM

Chest press	Bent-over rows
Rest	
Shoulder press	Lat pulldown
Rest	
Biceps curls	Triceps pushdowns
Rest	
Leg press	Romanian deadlift
Rest	
Calf raise	Anterior toe raise
Rest	
Ab curl-up	Back extension

Note: Perform both movements back-to-back, completing an autoregulated rest period between sets

CIRCUIT TRAINING CAN BE AN EXCELLENT ALTERNATIVE

Clients with a low training age often struggle with supersets and drop sets due to their low fatigue thresholds. Furthermore, they may struggle with higher relative loads due to their lack of neural recruitment. Therefore, the use of circuits is an effective time-saving alternative for those not ready for more traditional strength training. Circuit training is the systematic completion of movements with little to no rest between them, which is typically more cardiovascular in nature and not ideal for muscle hypertrophy or strength. However, clients with a low training age are very sensitive to training and will likely show substantial benefits from this form of training. After a base of general physical fitness is established, through circuit training, they can be transitioned to any of the aforementioned strategies. A sample total body circuit program is provided in Table 2.

QUALITY OVER QUANTITY

In summary, longer rest intervals (three minutes or more), are likely superior for strength and hypertrophy, with an autoregulated approach being optimal. Therefore, personal trainers should consider a quality over quantity approach, choosing longer rest intervals, with a lower overall training density per session. Employing techniques such as supersets or drop sets can be appropriate and effective strategies to save time.

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TABLE 2. SAMPLE TOTAL BODY CIRCUIT TRAINING PROGRAM

Squats	20 repetitions
Romanian deadlifts	20 repetitions
Chest press	20 repetitions
Seated horizontal rows	20 repetitions
Seated vertical rows	20 repetitions
Biceps curls	20 repetitions
Triceps extensions	20 repetitions
Planks	(30 – 45 s)

Note: Perform these movements in a series, with as little rest as possible between exercises. Completing as many circuits as appropriate for the client's ability.

**Substitute dumbbells or kettlebells for barbells where needed.*

ABOUT THE AUTHOR

AJ Mortara is an Associate Professor at Berea College, chairs the Health and Human Performance Department, and directs the human performance laboratory. Mortara teaches in the exercise science curriculum, including classes such as sports nutrition, exercise physiology, biomechanics, personal training certification, and others. Mortara's research interests include exercise metabolism and electromyography. Mortara received his Master's degree from Eastern Kentucky University and his Doctorate of Education degree from the University of Kentucky. Prior to working in education, Mortara specialized in work conditioning and work hardening for Toyota Motor Manufacturing.

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