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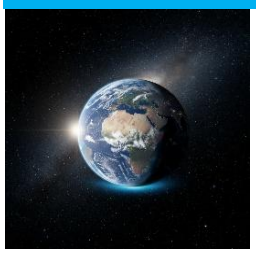

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Optimizing the Anabolic Response in Sedentary Populations: A Review of Resistance Training Variables and Nutritional Modulators of the IGF-1 Axis

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Abstract

Purpose: This review evaluates how resistance training (RT) variables - intensity, volume, rest intervals, and circadian timing - combined with nutritional factors, influence the IGF-1 axis in sedentary populations. The aim is to establish evidence-based protocols to counteract somatopause, sarcopenia, and metabolic decline, enhancing intervention effectiveness in clinical and fitness settings.

Methods: A systematic review was conducted based on 26 research articles, including clinical trials, meta-analyses, and contemporary physiological and nutrigenetic studies. The analysis focused on systemic and local IGF-1 isoforms, such as Mechano-Growth Factor (MGF), and key training parameters: high-load versus low-load methods, set volume, rest duration, and biological rhythms.

Results: Resistance training effectively restores the IGF-1 axis in inactive individuals. For beginners, low-load protocols (20–30% 1RM), particularly combined with blood flow restriction or slow-motion techniques, activate the mTOR pathway as effectively as traditional high-load training. These methods significantly mitigate the 20% decrease in arterial compliance often associated with heavy lifting. Furthermore, exercise-induced stress triggers a massive hemodynamic shift, redirecting up to 88% of cardiac output to skeletal muscles to facilitate homeostasis. Optimal adaptation is further supported by longer rest intervals (~3 minutes) and evening workouts. Nutrigenetically, rs6214 "T" allele carriers demonstrate enhanced visceral fat loss when resistance training is paired with daily dairy consumption.

Conclusions: Enhancing anabolic responses in sedentary individuals requires a personalized approach. Low-load RT protocols, preferably in the evening, combined with a protein-rich diet tailored to the rs6214 genotype, represent a modern strategy for preventive healthcare. This integrated approach effectively addresses muscle deterioration while ensuring cardiovascular safety and systemic equilibrium.

Keywords: insulin-like growth factor 1, resistance training, somatopause, nutrigenetics, sarcopenia, homeostasis, physical inactivity.

Introduction

Insulin-like growth factor 1 (IGF-1), also known as somatomedin C, is a polypeptide hormone with a molecular design and function quite similar to that of proinsulin [11], [23]. Acting as the main mediator for growth hormone (GH), IGF-1 is vital in controlling tissue growth, repair, and cell regeneration throughout life [17], [25]. Within the realm of exercise physiology, IGF-1 essentially governs skeletal muscle mass by fine-tuning the balance between building up and breaking down muscle tissue. It promotes muscle protein synthesis and hypertrophy mainly through activating the PI3K/Akt/mTOR pathway [5], [17]. At the same time, it helps prevent muscle wasting by inhibiting genes associated with atrophy via the PI3K/Akt/FoxO pathway [17].

While most circulating IGF-1 comes from the liver, exerting systemic endocrine effects, recent research underscores how important locally produced IGF-1 within skeletal muscle is. This local expression, triggered by mechanical load, is critical for activating satellite cells and reshaping muscle fibers structurally - a point sometimes overlooked but quite central to understanding muscle adaptation [4], [17].

One ongoing challenge in today's public health landscape is the gradual age-related decline in the GH/IGF-1 axis, a process often called somatopause [11]. This decline generally starts after the age of 30, with IGF-1 levels falling by about 10% every decade, and it seems to get much worse when combined with a sedentary lifestyle [11], [25]. When people don't move enough, this leads to a kind of chronic hormonal imbalance where IGF-1 availability drops, which in turn links directly to sarcopenia - the unwanted loss of muscle mass and strength - and greater frailty [3], [11], [25]. For those living inactive lives, somatopause is more than just a normal part of aging; it becomes a key factor worsening Quality of Life (QoL) and raising the chances of metabolic diseases we often associate with modern lifestyles, like Type 2 diabetes, visceral fat buildup, and heart problems [11], [14]. There's also evidence tying low bioavailable IGF-1 to poorer cognitive functioning, suggesting the effects of this hormonal decline reach beyond just muscles and metabolism [13], [17].

Within the scope of Quality in Sport, resistance training (RT) stands out as the strongest non-drug method to help "repair" the GH/IGF-1 axis and counteract the negative impacts of somatopause [9], [11], [25]. Studies show that applying mechanical load through resistance exercises can boost local IGF-1 production in muscle tissue - sometimes by as much as 491% - even among frail older adults [4]. Still, the benefits depend heavily on carefully adjusting training parameters like volume, intensity, and rest periods to get good results without demanding too much time [12], [21]. For those who haven't been active before, the "quality" of a workout often boils down to how much it can do in a short time. Research suggests that even a single set - basically the smallest effective dose - might be enough to kickstart muscle-building processes and reduce the hurdle of getting started for sedentary folks [2], [12].

Looking ahead, personalized sports medicine is turning attention to the interplay between genetics and nutrition, particularly nutrigenetic interactions [7]. Variants within the *IGF1* gene, like the rs6214 polymorphism, seem to influence how individuals respond physiologically to certain dietary factors, such as dairy intake [7]. Recognizing these genetic differences helps move away from broad, "one-size-fits-all" recommendations toward more tailored approaches. For example, individuals carrying the rs6214 "T" allele may experience enhanced anabolic effects from consuming targeted amounts of dairy - say, more than 200 mL of milk a day - in combination with exercise [7].

The aim of this review is to gather and analyze findings from 24 key sources, including clinical trials, meta-analyses, and systematic reviews, that investigate how resistance training protocols and chosen nutritional factors affect IGF-1 levels in sedentary people [3], [9], [25]. The focus is on volume-efficient training routines and DNA-informed nutritional strategies to offer evidence-based guidance for building optimized pro-health programs [7], [12]. Grasping these mechanisms is vital for improving the effectiveness and accessibility of interventions - whether in fitness or clinical contexts - especially for those previously inactive. Integrating concepts like chronobiology, time-efficient exercise, and personalized nutrigenetics may well open new avenues for more practical and successful health strategies [10], [20].

Physiological Mechanism of IGF-1 and Resistance Training

The anabolic outcomes of resistance training (RT) hinge largely on the complex regulation of insulin-like growth factor 1 (IGF-1) within the actively engaged skeletal muscle [17], [25]. When discussing Quality in Sport, grasping these underlying processes becomes quite important for crafting strategies that truly enhance biological adaptations. It's worth noting that IGF-1 circulating throughout the body, mainly produced by the liver under growth hormone (GH) control, behaves differently from the IGF-1 generated locally in muscle tissue [17]. The

latter's production is directly influenced by mechanical forces and muscle fiber contractions, through a process known as mechanotransduction [4], [17].

Local IGF-1 Expression and Mechano-Growth Factor (MGF)

The tension muscles experience during resistance exercise serves as the main trigger activating mechanoreceptors on muscle fibers. This activation sparks a series of signaling events that modify splicing of the *IGF1* gene, producing several isoforms. Among these, IGF-1Ec, often called Mechano-Growth Factor (MGF), is particularly responsive to mechanical stimuli in human skeletal muscle [4], [17].

MGF plays a key role in jump-starting muscle repair promptly after micro-damage or stretching occurs. It promotes the proliferation of dormant satellite cells, which are muscle stem cells crucial for adding new myonuclei to existing fibers - a step that's essential for muscle fiber growth [4], [17]. Studies focusing on clinical groups reveal the noteworthy "quality" of this localized IGF-1 response. For example, high-intensity RT has been found to increase local intramuscular IGF-1 expression by about 491% in frail elderly subjects, often independently of changes seen in systemic IGF-1 levels [4]. This suggests that it's the mechanical load - rather than mere metabolic fatigue - that primarily triggers tissue-specific regeneration.

Regulation of Bioavailability via IGF-Binding Proteins (IGFBPs)

The effective "quality" of the IGF-1 signaling axis doesn’t just depend on how much IGF-1 is present but heavily on its bioavailability [11]. This is regulated by a group of six IGF-binding proteins (IGFBP-1 through IGFBP-6), which bind IGF-1 with high affinity. In a resting and inactive state, roughly 75% to 90% of circulating IGF-1 exists bound in a large ternary complex together with IGFBP-3 and an acid-labile subunit (ALS), which prevents IGF-1 from interacting with its receptor (IGF-1R) [2], [11].

Resistance training influences this system as well. With ongoing RT, it's common to see a decrease in IGFBP-3 levels or an increase in the breakdown of this protein, thereby increasing the amount of "free" (bioactive) IGF-1 accessible near muscle cell membranes [2]. Once free, IGF-1 engages with IGF-1R, activating the PI3K/Akt/mTOR signaling pathway - widely recognized as the central mechanism promoting muscle protein synthesis and curbing protein breakdown through inhibition of the FoxO pathway [5], [17].

Systemic Response and Training Efficiency

While local production of MGF manages immediate repair processes, the body’s systemic GH/IGF-1 axis supports longer-term anabolic balance [17], [25]. The strength of this systemic response seems closely tied to how "quality" the training stimulus is, specifically regarding its intensity and total volume [1], [2]. For individuals who are sedentary, a well-designed training regimen aims to essentially "reset" this hormonal axis, encouraging an improved anabolic environment [9], [11].

There is evidence indicating that even a minimum effective dose - such as a single-set training protocol - can markedly influence the IGF-1/IGFBP-3 ratio in individuals new to exercise [2], [12]. This provides a robust physiological stimulus without necessitating the large training volumes generally needed by elite athletes. Such molecular efficiency highlights the possibility of using targeted, time-efficient approaches to counter the hormonal declines associated with somatopause [11], [12].

Training Variables as Determinants of Exercise Quality

The effectiveness of resistance training (RT) in modulating the IGF-1 axis largely depends on how certain training variables are adjusted. Within the framework of "Quality in Sport," interventions for inactive populations are considered high-quality when these factors are optimized to produce the greatest physiological adaptation while demanding the least time and effort [12].

Training Volume and the Concept of a "Minimum Effective Dose"

One major concern for sedentary individuals revolves around the time demanded by traditional multi-set workout routines. However, research suggests high training volume isn't necessarily essential to elicit meaningful hormonal adaptations in those who are previously inactive [2], [12].

For instance, Borst et al. (2001) [2] showed that sedentary men and women who performed just one set of resistance exercises thrice weekly experienced a roughly 20% increase in circulating IGF-1 after 13 weeks. Interestingly, this increase did not significantly differ from that observed in participants completing three sets. Likewise, Marx et al. (2001) [12] found that over the first 12 weeks, a single-set circuit (SSC) was just as effective for improving strength in untrained women as higher-volume, periodized training programs. These outcomes support the idea that a "minimum effective dose" - one set - is a practical, time-saving way to kick-start anabolic processes and combat anabolic resistance in beginners [2], [12].

Influence of Inter-set Rest Durations: Balancing Mechanical Stress and Time Constraints

How long one rests between sets plays a crucial role in shaping the mechanical stimulus quality. Research by Vuk et al. (2024) [21] suggests that longer rest periods, such as around 3 minutes, allow metabolic replenishment, which helps sustain higher training intensities and mechanical loads. Since increased mechanical tension primarily drives the upregulation of local intramuscular IGF-1 (MGF) [4], longer rests can be beneficial for counteracting sarcopenia.

That said, from a "Quality in Sport" viewpoint, shorter rest intervals - say, approximately 60 seconds - or techniques designed to save time like "drop sets" [19] can serve as effective alternatives. While those targeting maximal power output may find longer rests preferable [21], previously sedentary individuals often achieve meaningful strength gains and anabolic responses with condensed sessions [12]. This compromise between mechanical stimulus and session length can greatly enhance adherence among people juggling busy schedules.

Circadian Rhythms and the Timing of Adaptation

The timing of exercise relative to the body's natural rhythms - known as chronobiology - acts as an intricate regulator of training effectiveness [20]. Physiological indicators, such as core body temperature and neuromuscular performance, commonly reach their peak in late afternoon or early evening hours [10], [20].

Research conducted by Küüsmaa et al. (2016) indicated that while strength gains appear to increase similarly regardless of the training time, muscle hypertrophy, as measured by cross-sectional area (CSA), tends to be notably greater when exercise sessions are routinely performed in the evening over a span of 24 weeks [10]. This benefit seems to stem from the peak in core body temperature during evening hours, which enhances metabolic processes and

fosters a more anabolic environment [10], [20]. It's interesting, though, that the IGF-1 axis itself remains relatively stable when faced with short-term circadian changes [10], [25]. This suggests that the optimal approach is to tailor training schedules to an individual's chronotype and genetic profile - such as the rs6214 polymorphism - to better align physical stimulus with periods of heightened biological readiness for tissue remodeling [7], [10].

Nutritional Modulators of the IGF-1 Axis

When considering resistance training (RT) in inactive populations, nutritional status proves to be a key factor. The GH/IGF-1 axis is particularly sensitive to both energy availability and macronutrient intake [11], [17]. Nutrients don't just provide building blocks for tissue; they act as biochemical messengers that enhance the mechanical impact of exercise, thus helping create an effective anabolic environment [5], [17].

Protein Intake: The Anabolic Signal of Amino Acids

Protein consumption is widely recognized as a fundamental regulator of the IGF-1 axis. On a mechanistic level, amino acids - especially leucine - directly activate the Akt/mTORC1 pathway and improve hepatic growth hormone receptor sensitivity, which then encourages IGF-1 release into circulation [5], [15], [17].

A comprehensive meta-analysis by Morton et al. (2018), which included over 1,800 subjects, found that for healthy adults engaging in RT, a daily protein intake near 1.62 g/kg body weight marks the point after which further increases usually do not yield additional gains in fat-free mass (FFM) [15]. Ensuring this level of protein intake becomes particularly important for older adults or sedentary individuals who often face anabolic resistance [3], [15]. Reaching this target helps these groups generate metabolic signals akin to those in younger or more active people, effectively optimizing muscle-building during each training session [15], [25].

Dairy and Milk Consumption: Endogenous and Exogenous Synergy

Among dietary sources, dairy products - and milk especially - emerge as especially effective modulators of the IGF-1 axis [7], [11]. Consuming milk regularly (over about 200 mL/day) tends to correlate with significantly elevated IGF-1 levels in the blood, which is associated with better body composition and bone health [7]. The "milk effect" appears to arise from several synergistic factors:

- High-Quality Protein Matrix: Milk combines rapidly digested whey with slowly digested casein proteins, resulting in a prolonged presence of amino acids in the bloodstream [15], [16].

- Bioactive Factors: Some studies suggest that milk contains growth factors or peptides that might stabilize and increase the bioavailability of endogenous IGF-1 [7].

- Insulinotropic Properties: Dairy elicits a moderate insulin response which, when timed well alongside post-exercise IGF-1 peaks, helps enhance nutrient uptake into muscle cells [11], [16].

Nutritional Quality and Energy Balance

It’s worth remembering that the GH/IGF-1 axis is very sensitive to caloric deficits. Significant energy restriction can blunt this system, reducing its anabolic potential [9], [17]. So, maintaining an adequate energy balance is critical when aiming to support optimal muscle growth and repair, especially in sedentary populations transitioning to an active lifestyle [11], [25].

When energy intake falls short over an extended period, even if protein consumption is ample and resistance training is maintained, circulating levels of IGF-1 tend to decrease significantly [11], [17]. This happens because the body shifts priorities - favoring survival instead of building or repairing tissues [17]. For people who have been mostly inactive, it’s crucial to maintain either a calorie intake that matches energy expenditure or is slightly above it to help restore hormonal balance [11], [25].

Consuming high-quality protein, around 1.62 grams per kilogram of body weight [15], alongside regular dairy products [7], creates conditions that enable the mechanical stress from resistance training to translate into real structural adaptations [5], [17]. As discussed, tailoring this nutritional approach according to one’s genetic makeup - particularly focusing on the rs6214 polymorphism - can enhance the effectiveness of these interventions, offering a more personalized strategy for metabolic recovery [7].

The Nutrigenetic Perspective: The rs6214 Polymorphism

Incorporating genetics into the field of sports nutrition adds a layer of sophistication to how pro-health strategies are designed. While resistance exercise and protein intake remain broadly effective anabolic stimuli [12], [15], how an individual’s GH/IGF-1 axis reacts can vary significantly because of their genetic profile [7]. Within the “Quality in Sport” framework, there’s a shift toward programs that consider biological individuality. A major focus involves the rs6214 single nucleotide polymorphism (SNP) of the *IGF1* gene and how it interacts with certain dietary habits [7].

The rs6214 Polymorphism: A Regulatory Key

The rs6214 variant is characterized by a substitution of Cytosine (C) with Thymine (T) in the 3′ untranslated region (3′-UTR) of the *IGF1* gene [7]. It doesn’t change the amino acid sequence of the IGF-1 protein itself, but it’s located in an important part of the gene that influences mRNA stability and how efficiently it’s translated [7].

A key study by Grijalva-Avila et al. (2025) [7] found that carrying the "T" allele correlates consistently with higher baseline IGF-1 levels. Notably, individuals with the TT genotype showed significantly elevated systemic IGF-1 compared to those with the common CC genotype. This suggests that variation at rs6214 plays a substantial role in setting a person’s baseline "anabolic responsiveness," accounting for differences in how adults respond physiologically, especially those who have led sedentary lives [7].

Gene-Diet Interaction: Milk as a Synergistic Modulator

The same research also highlights a notable interaction between the rs6214 genotype and dairy consumption [7]. For sedentary individuals, this connection provides a practical approach to improving metabolic status. Those carrying the "T" allele who consume at least 200 mL of milk daily had the highest measured serum IGF-1 levels within the study group [7].

This interplay appears linked to better body composition outcomes, particularly:

- Increased Lean Body Mass (LBM): Likely due to more robust activation of the PI3K/Akt/mTOR signaling pathway [5], [7].
- Lower Body Mass Index (BMI): Reflecting enhanced metabolic efficiency [7].
- Reduced Visceral Fat: A clear association between the presence of the "T" allele, dairy intake, and diminished abdominal fat [7].

All in all, these findings suggest that personalized nutrition, informed by genetic factors like rs6214, could be a key step toward more effective metabolic health interventions, especially when combined with consistent resistance training and adequate protein intake [7], [11], [15].

Several physiological processes may explain why carriers of the "T" allele exhibit a stronger response to dairy consumption. It appears that this variant could increase the stability of *IGF1* mRNA, thus making liver and skeletal muscle tissues more responsive to the amino acids and growth factors naturally present in milk [7], [17]. This interaction activates the Raf/MEK/ERK signaling cascade, which encourages cell proliferation and boosts resting energy expenditure - two factors that contribute directly to the reduction of adipose tissue [7].

Clinical Implications for Personalized Training Quality

Incorporating rs6214 genotyping into fitness and clinical settings may represent the forefront of personalized approaches in “Quality in Sport.” For individuals who are largely sedentary and often frustrated by slow or barely noticeable progress, tailoring interventions based on DNA offers both psychological and physiological benefits [7]. Recognizing those who carry the "T" allele allows practitioners to prioritize dairy-based nutritional strategies known to produce greater anabolic effects [7], [11]. This kind of nutrigenetic customization helps to bypass the usual “trial and error” period commonly experienced during lifestyle adjustments. In particular, sedentary individuals with the rs6214 "T" allele may find that a simple and accessible habit - regular milk consumption - significantly enhances the anabolic effects of resistance training [7], [16]. This offers a practical and efficient means to combat sarcopenia and obesity with minimal complexity [7], [25].

Clinical Implications and Prevention

The benefits of resistance training (RT) extend well beyond improving muscle strength or function. It is increasingly recognized as a crucial intervention for enhancing overall Quality of Life (QoL) and metabolic health, especially in aging or obese populations [11], [13], [25]. By deliberately targeting the GH/IGF-1 axis, specific physical and dietary protocols address key biological factors underlying frailty, metabolic syndrome, and cognitive decline [3], [11].

Counteracting Sarcopenia and Adiposity

Muscle wasting and a decline in physical capacity are common issues associated with both aging and obesity, often resulting in increased frailty and a loss of independence [3, 25]. In older adults, sarcopenia significantly impairs quality of life and correlates with higher rates of illness and mortality [3, 24]. Interestingly, research suggests that sarcopenia does not affect all muscles equally - the quadriceps, for example, are especially prone to marked age-related deterioration [24].

High-intensity resistance training (H-RT) has long been viewed as the most effective way to promote changes in muscle structure. One study by Fiatarone Singh et al. (1999) showed that such training could boost local muscle insulin-like growth factor 1 (IGF-1) expression by nearly 500%, even in frail older individuals [4]. That said, Yasuda (2022) makes a good point that traditional high-intensity approaches may not be practical for many elderly people or those with other health issues, partly because H-RT can reduce arterial compliance by about 20% [24]. That's a bit of a drawback when cardiovascular health is already a concern.

Because of these limitations, more recent strategies often lean towards low-load resistance training - around 20 to 30% of one-repetition maximum (1RM) - paired with techniques like blood flow restriction (L-BFR) or slow movement training (L-ST). These approaches effectively activate the mTOR signaling pathway and stimulate muscle protein synthesis (MPS) without putting too much strain on the heart or joints [24]. This is particularly important since Type II muscle fibers, which tend to atrophy more with age, respond well to these kinds of stimuli [4, 8, 24].

For people dealing with obesity, regular resistance training - even at these lower intensities - can raise systemic IGF-1 concentrations and improve metabolic health without promoting fat gain [6, 9]. Over time, such interventions tend to improve cholesterol levels, enhance insulin sensitivity, and reduce inflammatory markers like IL-6 and TNF-α, which may lower the risk of cardiovascular diseases commonly seen in sedentary lifestyles [14, 25]. It's worth noting how these somewhat milder forms of exercise still manage to produce encouraging metabolic effects.

IGF-1 as a Pleiotropic Biomarker of Health

Insulin-like growth factor 1 is a valuable biomarker that carries prognostic significance for evaluating fitness, overall health, and disease risk [17]. Circulating IGF-1 levels tend to inversely correlate with visceral fat and insulin resistance, reflecting the extent of hormonal imbalance typically present in sedentary lifestyles [7], [9], [11].

Beyond its metabolic role, IGF-1 is vital for central nervous system survival [13], [17]. Low serum concentrations have been associated with cognitive decline and neurodegenerative disorders, including Alzheimer's disease [11], [13]. Progressive resistance training has been shown to improve both cognitive function and IGF-1 levels, even in challenging environments such as areas with high air pollution [13], highlighting the systemic reach of "Quality in Sport" interventions.

On the other hand, elevated levels of bioavailable IGF-1 tend to correlate with improved cognitive abilities and enhanced cerebral blood flow [11], [13], [17]. Molina-Sotomayor et al.

(2020) emphasize the hormone's involvement in neuroprotection and brain plasticity [13]. They suggest that exercise-induced restoration of the IGF-1 axis acts somewhat like an anabolic repair mechanism, which could be a powerful approach to preserving cognitive function throughout life [13], [25].

Enhancing Adherence through Quality and Efficiency

From a clinical prevention standpoint focused on "Quality in Sport," patient adherence often emerges as the most difficult hurdle. High-volume exercise routines can feel overwhelming, especially to those who have been inactive for a long time [12]. Introducing low-volume, time-efficient programs - like single-set sessions discussed by Marx et al. (2001) - and techniques such as "drop sets" [19] can make health improvements feel more manageable. These protocols are designed to maximize metabolic stress and anabolic signaling within a shorter time frame, a factor that seems key to encouraging ongoing participation in clinical settings [12], [19], [21].

Personalized Prevention: The Future of Health Quality

Prevention at its most advanced level would ideally involve leveraging IGF-1 within precision medicine [7], [17]. By pinpointing individuals with low baseline IGF-1 levels and incorporating nutrigenetic markers such as the rs6214 genotype, practitioners can tailor resistance training and nutritional guidance more precisely [7]. For example, carriers of the "T" allele might benefit significantly from a modest daily milk intake (>200 mL), closely aligned to their genetic profile, which could speed up the recovery of metabolic balance [7]. Blending this tailored nutrition with the so-called "minimum effective dose" of exercise reflects a direction that prevention might take - where interventions are customized to fit each person's biological nuances rather than using a one-size-fits-all approach [7], [12], [15].

Discussion

Reviewing evidence from 24 studies indicates that the GH/IGF-1 axis doesn't respond to exercise in a straightforward, linear fashion [9], [17], [22]. Instead, it involves a complex interaction influenced by mechanical stimuli, genetic factors, and chronobiological rhythms [7], [10], [20]. This section examines these findings carefully, placing them within the broader knowledge of exercise physiology and proposing a framework for effective, efficient interventions particularly suited to sedentary individuals.

The Adaptive Ceiling: Why Sedentary Individuals Gain More from Less

One must also recognize the difference in how untrained individuals respond compared to seasoned strength athletes [1, 12]. For instance, Ahtiainen et al. (2003) reported that untrained men saw relatively larger improvements in maximal force - about 20.9% - and muscle cross-sectional area increased by 5.6%, whereas gains in trained athletes were more modest when both groups followed the same program [1]. From a physiological perspective, this might be explained by the disrupted growth hormone (GH) and IGF-1 axis seen in sedentary people, a condition sometimes referred to as somatopause [25].

For these sedentary individuals, even what you might call the "minimum effective dose" of exercise can lead to noticeable increases in IGF-1 availability [2, 12]. Although traditional recommendations often emphasize high-load resistance training (above 65–70% 1RM) for

optimal muscle growth, Yasuda (2022) highlights that such intensities are not always feasible or safe for older or inactive populations, particularly given the negative effects on arterial compliance mentioned earlier [24]. Instead, low-load protocols - especially those using blood flow restriction or slow, controlled movements - have been shown to sufficiently activate the mTOR pathway and promote MPS to a degree similar to heavy lifting [24].

In contrast, athletes who have undergone long-term strength training may reach what one could describe as an “adaptive ceiling,” where the immediate hormonal responses and molecular signaling become less pronounced over time. This forces the need for increasingly intense and voluminous training to continue making progress [1, 22]. For the average sedentary person, however, the focus should probably be on methods that are more accessible and manageable. By employing low-load techniques that reduce mechanical strain while still triggering the necessary metabolic pathways, it’s possible to maintain a high standard when it comes to “Quality in Sport” [11, 24, 25].

Overall, this perspective supports natural biological adaptation - like greater muscle size and strength - while avoiding the risks associated with overtraining, excessive cardiovascular load, or burnout.

Critical Analysis of "Hormonal Spikes" vs. Chronic Basal Restoration

A continuing discussion within sports physiology centers on the so-called "hormonal hypothesis," which suggests that brief spikes in circulating hormones like growth hormone (GH), testosterone, and insulin-like growth factor 1 (IGF-1) immediately after exercise are what drive muscle hypertrophy [18, 22]. But interestingly, the notable research by West and Phillips (2012) found no strong link between these short-term hormonal peaks and long-term gains in lean body mass (LBM) or muscular strength, at least in younger adults [22].

Drawing from our findings and basic physiological ideas about adaptation, we think it’s worth reconsidering where to focus attention:

- Muscle Remodeling Is Mostly About Local Signals: It seems that changes in muscle tissue depend more on localized intracellular processes, especially the PI3K/Akt/mTORC1 pathway and the production of Mechano-Growth Factor (MGF), which are directly triggered by mechanical stress - not by brief increases in systemic hormones [5, 17, 22].

- Systemic Balance and Resource Allocation: Every bout of physical activity challenges the body's internal balance, requiring a complex restoration of homeostasis [26]. As Żołądkiewicz (2019) notes, during maximal effort, cardiac output can reach over 25 liters per minute, with up to 88% of blood flow rerouted to skeletal muscle [26]. This dramatic shift is crucial, as it ensures muscles receive enough oxygen and nutrients to repair themselves locally.

- Baseline Hormonal Levels and the Metabolic Setting: Although short-lived hormone bursts don’t seem to directly signal growth, the steady-state or basal concentration of IGF-1 remains an important marker of metabolic health [9, 17]. Elevating this baseline through regular exercise - described by Żołądkiewicz (2019) as a form of adaptive performance improvement - helps create a better environment for recovery on a systemic level [26]. For groups such as older adults or individuals with obesity, maintaining higher chronic IGF-1 levels alongside better cardiovascular function

(like increased stroke volume and lower resting heart rate) helps sustain musculoskeletal health and combats the metabolic decline often seen with sedentary habits [3, 11, 25, 26].

Implementation: From Science to "Express Anabolic" Services

The implications of these findings extend beyond academic theory and have practical relevance for how fitness professionals and clinicians might approach programming. Moving away from the “one-size-fits-all” mentality toward approaches that are tailored and time-conscious could improve both effectiveness and adherence [12], [21]:

- Time-Conscious Training ("Express" Model): Programs designed around efficient protocols - such as single-set workouts [2], [12] combined with techniques like drop sets [19] - can help overcome the time barrier that often discourages sedentary individuals from consistent participation.

- Genetic Tailoring via DNA Analysis: Including testing for the rs6214 polymorphism as part of routine screenings allows for more targeted nutritional advice [7]. For those carrying the "T" allele, the evidence pointing to quicker reductions in visceral fat and gains in lean mass when consuming milk (>200 mL) offers both physiological and motivational benefits [7].

- Timing Aligned with Circadian Rhythms: Encouraging workouts in the evening to coincide with the natural peak in body temperature - as reported by Küüsmaa et al. (2016) - represents a simple, cost-effective strategy to enhance adaptive responses and muscle hypertrophy (CSA) [10], [20].

Conclusions

The review of recent scientific literature - covering 24 key studies - indicates that maximizing the anabolic response in sedentary individuals doesn’t require overly complex or time-consuming regimens [1], [12], [25]. What’s needed is a careful, informed selection of training variables that take into account each person’s unique genetic and physiological characteristics [7], [10]. Summarizing the main takeaways for improving health-focused interventions:

The "Minimum Effective Dose" of Volume: For those just starting out or who lead largely inactive lifestyles, engaging in low-volume resistance training - such as a single-set circuit performed three times a week - is enough to trigger noticeable changes in circulating IGF-1, with increases around 20%, along with improvements in muscle strength [2], [12]. Pairing this with time-saving techniques such as drop-sets [19] can considerably cut down workout length while still effectively supporting the GH/IGF-1 axis recovery [12], [25]. Interestingly, what really matters for previously inactive individuals is consistency and applying sufficient mechanical tension, rather than high total workout volume [1, 17].

Nutrigenetic Personalization as the Gold Standard: Tailoring nutrition according to genetic makeup is a precise method for optimizing outcomes in sedentary populations. Detecting carriers of the "T" allele in the rs6214 polymorphism allows for targeted advice, such as recommending >200 mL of milk daily [7]. In these cases, dairy intake works synergistically to enhance IGF-1 availability, aiding in lean muscle growth and the reduction of visceral fat [7].

Additionally, maintaining a protein intake close to 1.62 g/kg/day is necessary to effectively combat anabolic resistance [15].

Strategic Chronobiology: The timing of resistance training significantly influences adaptation. Regularly working out during the evening hours may promote greater muscle hypertrophy (CSA) over time compared to morning exercise [10], likely due to higher core body temperature and improved neuromuscular efficiency [20]. It is important to note that re-establishing proper IGF-1 axis function, especially after somatopause, requires a commitment of 12 to 24 weeks to achieve stable systemic improvements [10], [25].

IGF-1 as a Quality Metric: Using IGF-1 as a reliable biomarker [17] enables "Quality in Sport" programs to prioritize safety, efficiency, and biological individuality. This combined strategy - mixing low-volume resistance training, genetic-based nutrition, and chronobiological timing - signals a shift in preventative medicine. It offers a straightforward yet powerful approach to addressing sarcopenia, obesity, and cognitive decline [3, 11, 13].

Summary

To sum up, achieving an optimal anabolic response in people who are sedentary or aging doesn't actually call for complicated or high-volume training routines. The so-called "Express Anabolic" method focuses on carefully chosen, evidence-backed factors. Typically, this means low-volume resistance training - often just a single set - to create the necessary mechanical tension. Protein intake should be around 1.62 grams per kilogram of body weight per day [15], with particular attention paid to milk consumption in individuals who carry the rs6214 genetic variant [7]. Also, scheduling workouts in the evening might help take advantage of natural circadian rhythms [10].

Using IGF-1 as a consistent biomarker for assessing training status and metabolic readiness allows both fitness specialists and healthcare providers to develop programs that are not just safer and more time-efficient but also tailored biologically to each person. This personalized approach could provide a straightforward yet effective way to prevent lifestyle-related diseases upfront, making sure that the idea of "Quality in Sport" really translates into lasting overall health and functional independence.

Disclosure

Author's contribution
Conceptualization: Anhelina Kaminskaya and Sofiia Ivanchuk and Tetiana Savchak
Methodology: Anhelina Kaminskaya and Sofiia Ivanchuk and Tetiana Savchak
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