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Physiological and Performance Determinants of Competitive Fitness Challenge: A Multidimensional Analysis of Strength, Endurance, and Functional Performance

Cristian Băltărețu[1] , Costache Bogdan[2] , Virgil Tudor[3]

[13] National University of Physical Education and Sport, Bucharest, Romania
[2] *Bucharest University of Economic Studies*, Bucharest, Romania

Abstract

Fitness Challenge is an emerging competitive discipline characterized by the repeated execution of standardized strength-oriented and functional exercises under strict time constraints. Despite its rapid international development, the physiological and performance characteristics associated with competitive success have not yet been sufficiently established in the scientific literature. The purpose of this paper was to identify and critically integrate the main physiological and performance determinants potentially relevant to competitive Fitness Challenge. A structured integrative review was conducted using peer-reviewed research addressing muscular strength, local muscular endurance, aerobic capacity, anaerobic performance, functional fitness, fatigue, recovery, body composition, and performance prediction in high-intensity functional and hybrid exercise modalities. Official technical documentation defining the competitive demands of Fitness Challenge was also examined. Three research questions guided the analysis: which physiological capacities are most likely to influence Fitness Challenge performance, how evidence from related functional exercise modalities can inform the understanding of this discipline, and which variables should be prioritized in future Fitness Challenge-specific assessment models. The evidence indicates that competitive performance is unlikely to depend on a single physiological characteristic. Rather, it appears to emerge from the interaction between relative muscular strength, local muscular endurance, aerobic recovery capacity, anaerobic energy provision, movement efficiency, and resistance to fatigue. The main contribution of this paper is the proposal of a multidimensional framework for interpreting and investigating Fitness Challenge performance. This framework may provide a scientific foundation for athlete assessment, training prescription, talent identification, and future discipline-specific experimental research.

Keywords: Fitness Challenge, muscular strength, muscular endurance, aerobic capacity, functional performance.

1 Introduction

Fitness Challenge has emerged within the International Fitness and Bodybuilding Federation as a competitive discipline designed to evaluate physical performance through standardized exercise tasks. Unlike aesthetic disciplines traditionally associated with bodybuilding and fitness, competitive outcome in Fitness Challenge is determined directly by physical execution. Athletes perform a circuit comprising six exercise stations, with the objective of completing the greatest possible number of technically valid repetitions under predefined time, load, and movement standards (International Fitness and Bodybuilding Federation, 2026).

This structure places Fitness Challenge within a broader group of contemporary competitive exercise modalities combining resistance exercise, muscular endurance, cardiovascular stress, repeated high-intensity effort, and functional movement. However, Fitness Challenge should not be considered synonymous with CrossFit, high-intensity functional training, or hybrid fitness racing. The standardized structure of the competition, predetermined exercises, prescribed loads and repetition-based scoring system create a distinct competitive model and potentially a distinct physiological profile.

Understanding this profile is important for both scientific and practical reasons. From a performance perspective, coaches require evidence regarding the physical characteristics that should be developed, tested, and monitored. From a scientific perspective, the discipline provides an opportunity to study performance in a standardized functional exercise environment, potentially reducing some of the variability encountered in competitive formats in which the exercises change substantially between events.

Muscular strength is widely recognized as an important foundation of athletic performance because it contributes to force production, power development, movement efficiency, and the ability to perform sport-specific tasks (Suchomel et al., 2016). Nevertheless, maximal strength alone is unlikely to explain performance in a competition requiring high repetition volumes and repeated efforts. Local muscular endurance, aerobic recovery, anaerobic capacity and fatigue resistance are also likely to contribute.

Research in high-intensity functional exercise demonstrates that such exercise can impose substantial simultaneous cardiovascular, metabolic and neuromuscular demands (Feito et al., 2018; Maté-Muñoz et al., 2022). Studies investigating competitive functional fitness have further shown that performance may be associated with combinations of aerobic capacity, relative strength, power and body composition rather than with a single physiological marker (Butcher et al., 2015; Martínez-Gómez et al., 2020; Meier et al., 2023).

The problem is that these findings cannot automatically be extrapolated to Fitness Challenge. The specific competitive structure of the discipline requires direct scientific examination.

Accordingly, the purpose of this paper is to critically integrate the current evidence relevant to the physiological and performance demands of competitive Fitness Challenge and to propose a multidimensional framework for future athlete assessment and research.

2 Literature Review

2.1 Fitness Challenge as a Standardized Competitive Model

The International Fitness and Bodybuilding Federation describes Fitness Challenge as a competition structured around six strength-exercise stations in which athletes seek to achieve the maximum number of valid repetitions within the prescribed time available at each station (International Fitness and Bodybuilding Federation, 2026). Technical execution, standardized loads, valid repetition criteria and transitions between stations are therefore central elements of performance.

This competitive architecture has several physiological implications.

First, performance requires repeated force production rather than a single maximal voluntary effort. Second, exercise is performed under accumulating fatigue. Third, the athlete must recover sufficiently between successive tasks to maintain mechanical and technical performance. Finally, performance depends not only on physiological capacity but also on movement economy and the ability to distribute effort appropriately throughout the competition.

Fitness Challenge may therefore be conceptualized as a mixed-demand discipline situated at the intersection of resistance exercise, muscular endurance and repeated high-intensity functional exercise.

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2.2 Muscular Strength and Relative Strength

Muscular strength represents a fundamental component of athletic performance. Stronger athletes can generally produce greater absolute and relative forces and may perform a given submaximal resistance task at a lower percentage of their maximal capacity (Suchomel et al., 2016).

This concept is particularly relevant to Fitness Challenge. When two athletes are required to manipulate the same external load, that load may represent substantially different percentages of their individual maximal strength. The stronger athlete may consequently perform each repetition with a lower relative muscular demand.

The relevance of strength should therefore be evaluated predominantly through relative rather than exclusively absolute measures. This distinction is important in disciplines where athletes must repeatedly move their own body mass or standardized external resistance.

Suchomel et al. (2018) further emphasized that strength adaptations influence numerous performance qualities beyond maximal force production, including rate of force development and the capacity to express power. Accordingly, strength may act as a foundational determinant from which other performance qualities emerge.

Evidence from competitive functional fitness supports this interpretation. Butcher et al. (2015) observed relationships between selected strength and physiological characteristics and benchmark functional exercise performance, although the predictive contribution differed according to the specific workout. Martínez-Gómez et al. (2020) similarly demonstrated that competitive functional fitness performance is multifactorial and that strength- and power-related characteristics can contribute substantially to competition outcomes.

These findings are relevant but should be interpreted cautiously in Fitness Challenge because the competition structure and exercises are different.

2.3 Local Muscular Endurance

The capacity to repeatedly generate force without a substantial decline in performance is likely to represent one of the defining determinants of Fitness Challenge.

Local muscular endurance differs conceptually from maximal strength. An athlete may possess high maximal force but insufficient capacity to maintain repeated contractions. Conversely, an athlete with moderate maximal strength but superior fatigue resistance may perform effectively during prolonged repetition-based tasks.

Fitness Challenge consequently requires the interaction of strength and endurance within the same muscular system.

Resistance training literature indicates that muscular endurance is influenced by training load, volume, repetition characteristics and proximity to fatigue. The repeated performance requirements of Fitness Challenge suggest that athletes must develop both sufficient strength reserve and specific resistance to peripheral fatigue.

This interaction also explains why maximal-strength testing alone would provide an incomplete athlete profile. Future Fitness Challenge-specific assessment batteries should therefore combine maximal or near-maximal strength measures with standardized repetition-to-fatigue or fixed-duration muscular endurance assessments.

2.4 Aerobic Capacity and Recovery Between High-Intensity Efforts

Although many Fitness Challenge exercises are strength-oriented, aerobic metabolism should not be considered secondary.

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Aerobic fitness contributes importantly to recovery from repeated high-intensity exercise. Tomlin and Wenger (2001) showed that greater aerobic fitness can facilitate recovery between intense efforts through enhanced oxygen delivery, restoration of energy substrates and improved metabolic recovery.

The importance of this mechanism increases when multiple demanding tasks are performed sequentially.

Accordingly, maximal oxygen uptake may not directly determine the number of repetitions achieved within every individual station, but aerobic capacity may indirectly influence overall competition performance by facilitating recovery, maintaining work capacity and limiting the cumulative deterioration in performance.

This concept is supported by research in contemporary hybrid functional competitions. Brandt et al. (2025) reported strong associations between maximal oxygen uptake and performance in HYROX, while emphasizing the endurance-dominant characteristics of that particular competitive format. Fitness Challenge is structurally different and likely places relatively greater emphasis on local muscular endurance, yet the findings reinforce the broader importance of aerobic capacity in repeated mixed-mode competition.

Concurrent-training research also demonstrates that strength and endurance capacities can coexist at high levels, although their simultaneous development requires careful programming (Huiberts et al., 2024; Schumann et al., 2022).

For Fitness Challenge, this suggests that aerobic development should not be regarded as separate from strength preparation but as part of an integrated performance model.

2.5 Anaerobic Contribution and Metabolic Stress

The high repetition rate and intensity expected within individual Fitness Challenge stations indicate substantial involvement of anaerobic energy pathways.

When exercise intensity exceeds the capacity of oxidative metabolism to meet adenosine triphosphate demand, phosphagen and glycolytic pathways contribute increasingly to energy provision. Repeated high-intensity functional exercise can therefore produce substantial lactate accumulation, cardiovascular stress and perceived exertion.

Tibana et al. (2018) demonstrated marked heart-rate, blood-lactate and perceived-exertion responses during high-intensity functional workouts. Similarly, Toledo et al. (2021) showed that workouts with comparable external volume can produce different internal physiological loads depending on their structure.

These observations have particular relevance to Fitness Challenge. Two athletes achieving similar repetition totals may experience substantially different physiological strain, and the same athlete may respond differently depending on exercise sequencing, pacing and accumulated fatigue.

Future research should consequently distinguish external performance load, represented by valid repetitions and mechanical work, from internal load, represented by variables such as heart rate, blood lactate concentration and perceived exertion.

2.6 Fatigue and Recovery

Performance in Fitness Challenge develops under progressively accumulating fatigue.

Functional fitness research indicates that a single high-intensity session can produce measurable neuromuscular and metabolic perturbations extending into the recovery period (García-Fernández et al., 2021; Maté-Muñoz et al., 2022).

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This has two implications.

The first concerns competition performance. Athletes who can maintain repetition velocity and technical accuracy despite accumulating fatigue may possess an important competitive advantage.

The second concerns training design. The distribution of work and recovery may modify acute physiological stress. Hernández-Lougedo et al. (2021) demonstrated that introducing rest intervals into functional fitness exercise can alter acute responses and fatigue characteristics.

Fitness Challenge training should therefore develop not simply the capacity to perform individual exercises but the capacity to preserve technical efficiency when exercises are performed sequentially under fatigue.

2.7 Functional Performance and Movement Efficiency

Physiological capacity alone does not fully explain competitive performance.

The number of repetitions completed during a fixed period also depends on the energetic and mechanical cost of each repetition. An athlete capable of achieving the required technical standard with less unnecessary movement may conserve energy and sustain a higher work rate.

Movement efficiency consequently represents an important link between physical capacity and competition outcome.

This variable is difficult to quantify using conventional laboratory testing, which further supports the need for Fitness Challenge-specific performance assessments.

Repeated technical execution should therefore be evaluated alongside conventional indicators such as maximal strength and aerobic capacity.

2.8 Evidence from Related Functional Fitness Modalities

High-intensity functional training has been defined as a training model incorporating functional, multimodal exercises performed at relatively high intensity (Feito et al., 2018). A systematic review and meta-analysis by Wang et al. (2023) found evidence that high-intensity functional training can improve muscular strength, power, flexibility and sport-specific performance.

Competitive research in CrossFit has also attempted to identify performance predictors. Butcher et al. (2015) reported associations between physiological variables and specific benchmark performances, while Martínez-Gómez et al. (2020) showed that combinations of physiological variables predicted competitive outcomes.

A systematic review by Meier et al. (2023), however, demonstrated considerable heterogeneity across studies and highlighted the difficulty of identifying a universal predictor of performance.

This observation is particularly relevant to the present analysis. It reinforces the hypothesis that Fitness Challenge performance should be investigated multidimensionally rather than reduced to a single determinant.

Importantly, evidence from CrossFit or HYROX should be regarded as comparative rather than discipline-specific evidence. Fitness Challenge has its own competitive structure and consequently requires direct validation.

2.9 Research Gap

Despite the international expansion of Fitness Challenge, there remains a clear discrepancy between competitive development and scientific characterization.

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The available peer-reviewed literature provides substantial information regarding high-intensity functional exercise, concurrent strength and endurance development, fatigue, recovery and predictors of performance in related competitive modalities. However, direct evidence identifying the physiological determinants of standardized IFBB Fitness Challenge performance remains insufficient.

This gap limits evidence-based athlete profiling, talent identification, training prescription and competition preparation.

The principal novelty of the present paper therefore lies in organizing the available evidence around the specific structure of Fitness Challenge and proposing a discipline-specific multidimensional model that can subsequently be tested experimentally.

3 Methodology

3.1 Purpose and Research Design

The study employed a structured integrative review design to synthesize physiological and performance evidence relevant to competitive Fitness Challenge.

The approach was selected because direct discipline-specific experimental evidence is currently limited, whereas several adjacent fields provide experimentally derived information that can inform hypothesis development without being treated as direct evidence for Fitness Challenge.

Official International Fitness and Bodybuilding Federation technical documentation was used to establish the competitive characteristics of Fitness Challenge. Peer-reviewed literature was then examined to identify physiological variables with plausible relevance to those competitive demands.

3.2 Research Questions

The analysis was guided by the following research questions:

RQ1. Which physiological and physical-performance characteristics are most likely to contribute to competitive Fitness Challenge performance?

RQ2. To what extent can evidence from high-intensity functional training and related standardized functional competitions inform the understanding of Fitness Challenge performance?

RQ3. Which variables should form the basis of a multidimensional Fitness Challenge-specific athlete assessment model?

3.3 Literature Identification and Selection

Peer-reviewed research relevant to the study objective was identified principally through PubMed-indexed literature and supplemented through backward reference screening of major reviews and meta-analyses.

Search concepts included combinations of the following terms: *Fitness Challenge*, *functional fitness*, *high-intensity functional training*, *strength*, *relative strength*, *muscular endurance*, *aerobic capacity*, *maximal oxygen uptake*, *anaerobic performance*, *fatigue*, *recovery*, *body composition*, *functional performance* and *performance predictors*.

Priority was given to:

1. systematic reviews and meta-analyses;
2. original studies investigating physiological predictors of functional exercise performance;
3. research evaluating acute cardiovascular, metabolic and neuromuscular responses;

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4. studies investigating concurrent strength-endurance development;
5. official documentation defining Fitness Challenge competitive requirements.

Studies focusing exclusively on clinical populations or exercise outcomes with no conceptual relevance to competitive performance were not prioritized.

Because the objective was integrative rather than meta-analytic, methodological heterogeneity across the included research was interpreted qualitatively.

3.4 Analytical Framework

Evidence was organized into six domains derived from the competitive characteristics of Fitness Challenge:

1. muscular strength and relative strength;
2. local muscular endurance;
3. aerobic capacity and inter-effort recovery;
4. anaerobic contribution and metabolic stress;
5. fatigue resistance and movement efficiency;
6. functional and competition-specific performance.

Each domain was evaluated in relation to its theoretical and empirically supported contribution to repeated standardized exercise performance.

Evidence obtained from other functional fitness modalities was interpreted as indirect evidence and was not considered sufficient to establish causal determinants specifically for Fitness Challenge.

4 Analysis and Results Interpretation

The synthesis supports a multidimensional rather than unidimensional interpretation of Fitness Challenge performance.

4.1 Strength as a Performance Foundation

The literature consistently supports muscular strength as an important foundation for athletic performance (Suchomel et al., 2016, 2018). For Fitness Challenge, the most relevant mechanism is likely the reduction in relative intensity associated with prescribed external loads.

An athlete with greater strength relative to body mass should theoretically perform a standardized load at a smaller percentage of maximal capacity, potentially reducing the relative cost of each repetition.

However, strength alone cannot explain repeated-performance capacity.

Result of synthesis: relative muscular strength should be considered a major candidate determinant, but not an isolated predictor, of Fitness Challenge performance.

4.2 Muscular Endurance as a Discipline-Specific Requirement

The repetition-based scoring system makes muscular endurance directly relevant to competitive output.

Whereas maximal strength establishes force capacity, muscular endurance determines the ability to repeatedly express submaximal force while limiting the rate of performance decline.

Result of synthesis: local muscular endurance appears to be one of the characteristics most directly aligned with the competitive structure of Fitness Challenge and should receive high priority in future discipline-specific research.

4.3 Aerobic Capacity as a Recovery Determinant

Evidence from repeated high-intensity exercise indicates that aerobic fitness facilitates recovery between intense efforts (Tomlin & Wenger, 2001).

The sequential station format of Fitness Challenge creates repeated recovery demands even when individual exercises are not predominantly aerobic.

Result of synthesis: aerobic capacity is likely to influence overall performance principally through recovery kinetics and the preservation of work capacity across successive stations.

4.4 Anaerobic Capacity and Acute Exercise Stress

Functional high-intensity exercise produces substantial cardiovascular and metabolic stress, including elevated heart rate, blood lactate and perceived exertion (Tibana et al., 2018; Toledo et al., 2021).

These characteristics correspond closely to the high repetition rates and limited recovery opportunities inherent to competitive Fitness Challenge.

Result of synthesis: anaerobic energy provision and tolerance of metabolic perturbation are likely important, particularly within individual stations and during the later stages of competition.

4.5 Fatigue Resistance and Movement Efficiency

The reviewed evidence demonstrates that high-intensity functional exercise can cause significant acute fatigue and may require measurable recovery after exercise (García-Fernández et al., 2021; Maté-Muñoz et al., 2022).

In Fitness Challenge, fatigue may reduce repetition velocity, technical accuracy and overall movement economy.

Result of synthesis: fatigue resistance should be considered simultaneously physiological and technical. Athletes must not only maintain force production but also preserve efficient movement under increasing internal load.

4.6 Proposed Multidimensional Fitness Challenge Performance Model

Based on the integrated evidence, competitive Fitness Challenge performance may be represented conceptually as:

> **Fitness Challenge Performance = Strength Reserve × Muscular Endurance × Aerobic Recovery Capacity × Anaerobic Work Capacity × Movement Efficiency × Fatigue Resistance**

This expression is conceptual rather than mathematical and should not be interpreted as an experimentally validated predictive equation.

The model proposes that a marked limitation in one domain can restrict overall performance even when the athlete possesses superior characteristics in another.

For example, high maximal strength combined with poor muscular endurance may result in rapid performance deterioration. Conversely, high aerobic capacity without adequate strength reserve may limit repetition rate when prescribed resistance is relatively demanding.

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The interaction between domains is therefore likely more important than any isolated characteristic.

5 Discussion

The principal finding of this review is that competitive Fitness Challenge should be understood as a multidimensional performance discipline rather than as a pure strength or endurance event.

This distinction has important implications for research and coaching.

The first major domain is relative strength. Existing sport-science literature establishes muscular strength as an important determinant of numerous athletic actions (Suchomel et al., 2016). In Fitness Challenge, however, its relevance may be expressed primarily through strength reserve. Standardized resistance represents a lower relative intensity for stronger athletes, potentially permitting faster repetition rates and delaying local fatigue.

The second domain is muscular endurance. Because competitive ranking depends on repeated technically valid actions rather than maximal force, the ability to preserve force production is probably at least as important as the ability to generate peak force. This distinguishes Fitness Challenge from traditional strength sports.

The third domain is aerobic recovery capacity. The contribution of aerobic fitness to repeated high-intensity exercise is well established (Tomlin & Wenger, 2001), and evidence from hybrid fitness racing also suggests an important relationship between maximal oxygen uptake and competitive performance (Brandt et al., 2025). The magnitude of this contribution in Fitness Challenge remains unknown and should be directly quantified.

The fourth domain is anaerobic work capacity. Studies of high-intensity functional exercise demonstrate considerable metabolic stress, although responses differ according to workout characteristics (Tibana et al., 2018; Toledo et al., 2021). Fitness Challenge could provide an advantageous experimental model because exercise selection and competitive structure are standardized.

The fifth and sixth domains—movement efficiency and fatigue resistance—may explain why laboratory characteristics do not translate perfectly to competitive outcome. Two athletes with similar maximal oxygen uptake and strength may differ substantially in repetition economy, pacing decisions, transition efficiency and technical preservation under fatigue.

This may partly explain the heterogeneous predictive findings reported in other functional fitness research. Meier et al. (2023) concluded that performance prediction in CrossFit is complex and context dependent. Martínez-Gómez et al. (2020) similarly demonstrated that multiple physiological characteristics contribute to competitive performance.

These findings support rather than weaken the rationale for investigating Fitness Challenge. Because the discipline is more standardized, it may allow researchers to evaluate multidimensional determinants with reduced event-to-event variability.

A future experimental model should therefore assess competitive athletes using a standardized battery including body composition, maximal or near-maximal strength, relative strength, local muscular endurance, maximal oxygen uptake, anaerobic capacity, heart-rate response, blood lactate, perceived exertion and competition-specific repetition performance.

Multivariate statistical modelling could then establish which combination of variables independently explains competitive outcome.

This would represent an important progression from the conceptual framework proposed in the present paper toward a validated Fitness Challenge performance model.

6 Conclusions

The available scientific evidence supports the interpretation of competitive Fitness Challenge as a complex strength-endurance discipline characterized by repeated high-intensity functional work performed under accumulating fatigue.

The first research question can therefore be answered by identifying relative muscular strength, local muscular endurance, aerobic recovery capacity, anaerobic work capacity, movement efficiency and fatigue resistance as the most plausible candidate determinants of performance.

Regarding the second research question, evidence from high-intensity functional training, CrossFit and hybrid functional competitions can contribute meaningfully to hypothesis development, but it should not be interpreted as direct evidence for Fitness Challenge. The discipline-specific competition structure requires independent experimental validation.

Regarding the third research question, future Fitness Challenge athlete assessment should be multidimensional rather than based on a single performance indicator. A combination of physiological, neuromuscular, anthropometric and competition-specific variables appears most appropriate.

The main contribution of the present paper is therefore the development of an initial scientific framework for understanding competitive Fitness Challenge performance. This framework provides a basis for future experimental research, athlete profiling, training prescription, performance monitoring and talent identification.

The principal limitation is the limited volume of peer-reviewed research performed directly in Fitness Challenge athletes. Consequently, several relationships proposed in this paper are theoretically and indirectly supported rather than discipline-specifically validated.

This limitation simultaneously identifies the most important direction for future research: prospective studies involving competitive Fitness Challenge athletes performing standardized competition protocols under controlled physiological monitoring.

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