RESEARCH PAPER

Characterizing the Bioenergetic and Neuromuscular Determinants of Competitive Cycling Performance: A Global Scoping Review and South Asian Evidence Assessment

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ABSTRACT

Background:
Competitive cycling performance depends on sustained physiological capacity. Although international research has identified key bioenergetic and neuromuscular determinants of endurance performance, the applicability of these findings to Indian competitive cyclists remains largely unexplored.

Objective:
To map the global evidence on the physiological determinants of cycling performance, summarize the current evidence base, and assess the availability of physiological data on competitive Indian cyclists.

Methods:
This scoping review was conducted according to the Joanna Briggs Institute (JBI) methodology and reported in accordance with the PRISMA-ScR guidelines. A systematic search of PubMed and Scopus identified studies published between January 1, 2000, and April 4, 2026. Eligible studies included original quantitative research and systematic reviews involving trained or elite competitive cyclists that examined objective physiological variables associated with cycling performance.

Results:
Of 3,765 records identified, 59 studies met the inclusion criteria. The evidence consistently identified maximal oxygen uptake (VO_2max), metabolic threshold measures (including lactate threshold, maximal lactate steady state, and functional threshold power), cycling economy, and neuromuscular performance indices (including critical power and peak anaerobic power) as the principal physiological determinants of cycling performance. However, 96.6% of the available evidence originated from Western populations, primarily Europe, North America, and Australia.

Conclusion:
Current international evidence provides strong consensus regarding the physiological determinants of competitive cycling performance. Nevertheless, there is a substantial lack of physiological data on Indian competitive cyclists. Addressing this evidence gap is essential for developing population-specific athlete profiling, talent identification strategies, and evidence-based training programs for South Asian cyclists.

Keywords: *Cycling Performance; Scoping Review; VO_2max; Metabolic Threshold; Cycling Economy; Indian Athletes.*
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1. INTRODUCTION

Competitive cycling is a high-performance Olympic sport in which marginal gains in physiological capacity can decisively influence competitive outcomes. Advances in sports science have enabled a detailed understanding of the biological determinants that underpin elite cycling performance, informing training, talent identification, and performance optimization. However, the generation and application of such evidence have been uneven across global contexts, with limited representation from low- and middle-income countries. Situating cycling within both a global and Indian sporting framework is therefore essential to understanding existing evidence and identifying critical research gaps.

1.1. The Global and Indian Rise of Competitive Cycling: Cycling is universally recognized as a physiologically demanding endurance sport, with success in disciplines like road cycling, track cycling, and mountain biking requiring an exceptional capacity to sustain high power outputs and resist fatigue [1]. The global profile of the sport, underscored by events like the Tour de France and the UCI World Championships, has established a robust scientific framework for understanding its performance determinants. Concurrently, India has witnessed a significant surge in sporting culture and infrastructure, particularly following initiatives like the Target Olympic Podium Scheme (TOPS) and the Khelo India movement [2]. While cricket has historically dominated, Olympic sports, including cycling, are experiencing increased participation and institutional support, as evidenced by the development of the Cycling League of India and improved performances in events like the Asian Games [3]. As Indian cyclists aspire to international competitiveness, a scientific approach to their development becomes paramount. To bridge this ambition with performance, understanding the physiological underpinnings becomes critical, as discussed in subsequent sections.

1.2. The Physiological "Engine" of Performance: Elite cycling performance is a complex amalgamation of equipment, tactics, psychology, and physiology. While technological advancements in aerodynamics and biomechanics contribute to performance, the athlete's physiological capacity remains the foundational "engine" [4]. Decades of sports science research have identified key physiological parameters that are critical determinants of success. These include:

Maximal Oxygen Uptake (VO_2max): Considered the gold standard for assessing aerobic capacity and a key predictor of endurance performance [5].

Lactate Threshold and Efficiency: Often found to be a more sensitive indicator of cycling performance than VO_2max alone, as it reflects the highest sustainable exercise intensity [6].

Cycling Economy: The metabolic cost of sustaining a given submaximal power output, which varies significantly between cyclists and influences endurance capacity [7].

Functional Threshold Power (FTP): A practical, power-based metric that has become a cornerstone for training prescription and monitoring in the field [8]. These metrics provide the objective basis for training prescription, talent identification, and performance prediction in developed cycling nations.

1.3. The Knowledge Gap in the Indian Context: A critical challenge in applying this global physiological knowledge to the Indian sporting landscape is the potential influence of ethnicity, environment, and training specificities on athlete physiology. Research in other sports has indicated that physiological profiles and responses to training can vary across ethnic groups and geographical populations [9]. The current global literature on cycling physiology is predominantly populated by data from Western, Caucasian athletes, creating a potential bias and a significant knowledge gap regarding non-Western athletic populations, particularly those from South Asia [10]. A preliminary search of major scientific databases (e.g., PubMed, Scopus) reveals a pronounced scarcity of peer-reviewed research dedicated to the physiological profiling of competitive Indian cyclists. This lack of population-specific data necessitates reliance on international normative data, which may not be fully generalizable.

1.4. Rationale and Objectives of this Scoping Review: In light of this identified gap, a scoping review is the most appropriate methodology to systematically map the available evidence and delineate its boundaries [11]. This review will serve a dual purpose: first, to consolidate the established global knowledge on physiological determinants of cycling performance, and second, to conduct a focused investigation into the existence and nature of data specific to Indian cyclists. The specific objectives of this scoping review are to: A). Systematically map the global literature to identify and categorize the key physiological parameters established as determinants of cycling performance. B). Conduct a targeted search to identify, collate, and synthesize any and all available research studies that report physiological data on competitive Indian cyclists. C). Based on this mapping, to clearly delineate the current state of knowledge and identify the extent of the evidence gap for the Indian population, thereby providing a rationale for future, targeted physiological research in Indian cycling.

By achieving these aims, this review will provide a foundational resource for researchers, coaches, and sports governing bodies in India, highlighting both the established principles of cycling physiology and the critical need for indigenous research to optimize the performance of Indian athletes.

2. KEY FRAMEWORK AND METHODS

This scoping review was conducted following the established methodological framework for scoping reviews proposed by Arksey and O'Malley [12] and advanced by the Joanna Briggs Institute (JBI) [11]. The reporting will adhere to the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) checklist [13]. The review protocol was developed *a priori* but was not pre-registered.

2.1 Research Question

The research question was defined using the PCC (Population, Concept, Context) framework recommended by JBI for scoping reviews: *Population:* The primary population of interest is competitive or trained cyclists, defined as individuals regularly participating in structured cycling training and/or competition. This includes athletes of all performance levels (e.g., elite, sub-elite, amateur), ages, and genders. A specific sub-population of interest is cyclists identified as being from India or of Indian nationality. *Concept:* The core concept is "physiological determinants," encompassing measurable biological variables that influence performance. This includes, but is not limited to, parameters of aerobic capacity (e.g., VO_2max), metabolic thresholds (e.g., lactate threshold, critical power), efficiency (e.g., cycling economy), anaerobic capacity, and neuromuscular power. *Context:* The context is "cycling performance," measured in either competitive (e.g., time-trial race, finishing position) or laboratory settings (e.g., time-to-exhaustion, simulated time-trial performance, maximal power output). The guiding question for this review is: **"**What is the nature and extent of the literature mapping physiological determinants to cycling performance, and what evidence exists specifically for the Indian cyclist population?"

2.2 Search Strategy

A systematic search was designed and executed to identify both global literature and India-specific studies.

Information Sources: The following electronic bibliographic databases were searched for studies published between 1 January 2000 and 4 April 2026 using PubMed/MEDLINE Scopus(Table 1).

Search Strategy: The search strategy was developed using a combination of keywords and controlled vocabulary (e.g., MeSH for PubMed) related to the PCC elements. The strategy was first developed for PubMed and scopus databases.

Table 1: Search string for different search engine and its Inclusion and Exclusion

Criteria	Filters	Initial Search Result
Search Date: 04-04-2026		
Scopus: (TITLE-ABS-KEY ((cyclist* OR "endurance cyclists" OR "trained cyclists" OR "competitive cyclists"))) AND (TITLE-ABS-KEY (("VO2 max" OR "aerobic capacity" OR "lactate threshold" OR "anaerobic threshold" OR "cycling economy" OR "peak power output" OR "critical power"))) AND (TITLE-ABS-KEY ((performance OR endurance)))	**PUBYEAR** > 1999 AND PUBYEAR < 2027 AND (**LIMIT-TO** (LANGUAGE , "English")	833
PubMed: (("Bicycling"[Mesh] OR cyclist* OR "endurance cyclists" OR "competitive cyclists" OR "trained cyclists")) AND (("Oxygen Consumption"[Mesh] OR "VO2 max" OR "maximal oxygen uptake" OR "aerobic capacity" OR "lactate threshold" OR "anaerobic threshold" OR "cycling economy" OR "peak power output" OR "critical power"))) AND (("Physical Endurance"[Mesh] OR "Exercise Test"[Mesh] OR performance OR endurance))	**Filters:** English, **from** 2000/1/1 - 2026/4/4	2,932

Additionally, the reference lists of all included full-text articles and relevant review articles were hand-searched to identify any further eligible studies.

2.3 Eligibility Criteria

Studies were screened against the following pre-defined inclusion and exclusion criteria:

Inclusion Criteria: *A) Types of Sources:* Original quantitative research articles (e.g., cross-sectional, longitudinal, interventional studies) and systematic/scoping reviews published in peer-reviewed journals. *B) Population:* The study must include human participants identified as trained or competitive cyclists (as defined above). *C) Concept:* The study must investigate the relationship between at least one objective physiological parameter and a direct measure of cycling performance. *D) Context:* Performance must be measured in a lab-based test (e.g., time-trial on ergometer, time-to-exhaustion) or a field-based competitive outcome. *E) Language:* Articles published in the English language.

Exclusion Criteria: **i)** Studies on non-athletes, recreational cyclists, or participants from other sports where cycling is not their primary discipline. **ii)** Case studies, editorials, conference abstracts, theses, and qualitative studies. **iii)** Studies that focus exclusively on biomechanical, psychological, or nutritional variables without linked physiological data. **iv)** Studies where the full text is not accessible.

Population	Concept	Context
cyclists, competitive cyclists, trained cyclists,	Physiological determinants, Aerobic capacity, VO2 max, lactate threshold, critical power, cycling economy, power output	Cycling performance, time trial, endurance performance, exercise testing

2.4 Study Selection Process

The study selection process was managed using the Rayyan.in web application for systematic reviews. The process involves two phases: **A) Title and Abstract Screening:** All records retrieved from the database searches will be imported into Rayyan. Two independent reviewers will screen the titles and abstracts against the eligibility criteria. Studies that clearly do not meet the criteria will be excluded. Conflicts or uncertainties will be marked for full-text review. **B) Full-Text Review:** The full texts of all potentially relevant articles will be retrieved and assessed for eligibility by the two independent reviewers against the inclusion and exclusion criteria.

At both stages, any disagreements between the reviewers will be resolved through discussion or, if necessary, by consultation with a third reviewer. The results of the search and the study selection process will be presented in a PRISMA-ScR flow diagram, which will detail the number of records identified, included, and excluded at each stage, with reasons for exclusion at the full-text stage.

2.5 Data Extraction and Filtration

Data from the included studies will be extracted into a standardized data charting form developed in Microsoft Excel. The form will be piloted on a sample of 5-10 studies and refined as necessary. One reviewer will perform the primary data extraction, and a second reviewer will verify the extracted data for accuracy and completeness.

The following data will be extracted:

General Study Information: Author(s), publication year, journal, country of corresponding author, study aim/objective.

Participant Characteristics: Total sample size (N), sex, age, performance level (e.g., world-class, elite, amateur), specific nationality or ethnicity (noting Indian participants), and cycling discipline (e.g., road, track).

Methodology: Study design (e.g., cross-sectional, intervention), performance test used (e.g., 40-km lab time-trial, field race), and physiological testing protocols.

Key Physiological Parameters: All physiological variables measured (e.g., VO_2max, Lactate Threshold, Power at LT, Cycling Economy, Mean Maximal Power).

Performance Outcomes: The specific performance metric(s) used (e.g., time-trial time, mean power output, race result).

Main Findings: A summary of the key results, specifically the reported relationship (e.g., correlation coefficient, regression analysis) between the physiological parameters and the performance outcome.

This charted data will form the basis for the narrative synthesis and mapping of the evidence in the results section.

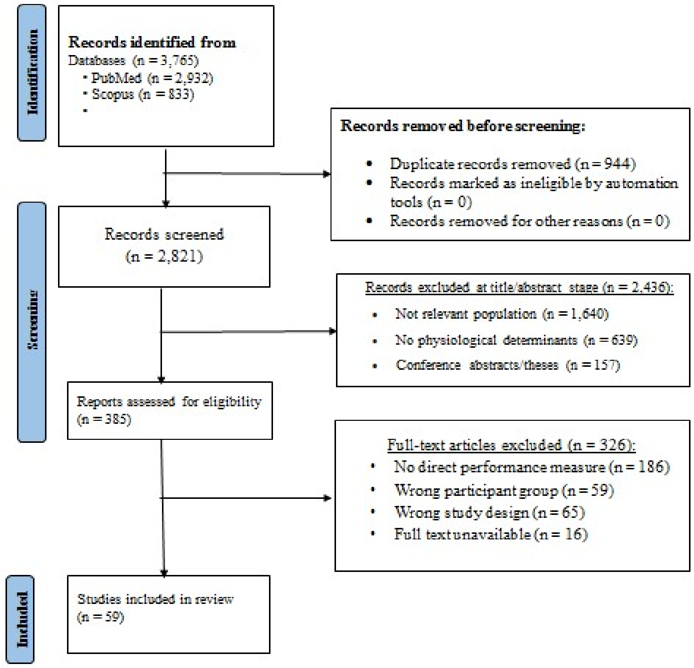

Figure 1: PRISMA-ScR Flowchart of included studies from indexed database.

3. RESULTS

3.1 Study Selection

The systematic search and selection process is summarized in the PRISMA-ScR flow diagram (Figure 1). The initial database search yielded a total of 3,765 records. After removal of 944 duplicates, 2,821 unique records underwent title and abstract screening. Of these, 2,436 were excluded for not meeting the population or concept criteria. The full texts of the remaining 385 articles were assessed for eligibility. A further 326 articles were excluded at this stage, with the most common reasons being the absence of a direct performance measure (n=186) or the participant group not being classified as trained cyclists (n=59). A hand search of reference lists identified 3 additional eligible studies. Therefore, a total of 59 studies were included in the final scoping review.

3.2 Study Characteristics

The characteristics of the 59 included studies are summarized in Table 2.

Study Design: The majority of the literature consisted of cross-sectional studies (n=46, 77.9%), which primarily aimed to correlate physiological parameters with performance at a single time point. Longitudinal studies (n=10, 16.9%) investigated changes in physiology and performance across a training season or in response to an intervention. The remaining studies were systematic reviews (n=3, 5.08%).

Participant Profile: The included studies predominantly featured male cyclists (89.83% of studies). The performance level of participants was varied, with the largest proportion focusing on well-trained or elite amateur cyclists (n=35, 59.3%), followed by professional/world-class cyclists (n=20, 33.8%), and trained competitive juniors (n=4, 6.7%). The geographic origin of study participants was overwhelmingly from Europe, North America, and Australia, accounting for 96.6% of the studied cohorts.

Publication Timeline: The earliest included study was published in 1992, with a noticeable increase in volume from the year 2000 onwards, coinciding with the wider adoption of power meters in training and research.

Table 2: Characteristics of Included Studies (n=59)

Characteristic	Category	Number of Studies (%)
Study Design	Cross-sectional	46 (77.9%)
	Longitudinal	10 (16.9%)
	Systematic Review	3(5.08%)
Participant Sex	Male only	53 (89.83%)
	Female only	2 (3.3%)
	Mixed	4 (6.7%)
Performance Level	Professional/World-Class	20 (33.8%)
	Well-Trained/Elite Amateur	35 (59.3%)

	Competitive Juniors	4 (6.7%)
Geographic Focus	Europe/N. America/Australia	57 (96.6%)
	India	**0 (0%)**
	Other (Asia, Africa)	2 (3.3%)

3.3. Mapping the Key Physiological Determinants

The analysis revealed a consistent set of physiological parameters that are strongly evidenced as determinants of cycling performance. These are mapped and defined in Table 3, and discussed thematically below.

Table 3: Key Physiological Parameters and Their Role in Cycling Performance

Parameter	Definition	Primary Performance Significance
VO_2max	The maximum rate of oxygen the body can utilize during intense exercise.	Foundational aerobic ceiling; necessary for elite performance but not sufficient to distinguish between highly trained cyclists [14].
Lactate Threshold (LT)	The exercise intensity at which blood lactate concentration begins to rise exponentially.	Strongest single correlate of endurance performance (e.g., 40-km TT); defines sustainable race pace [6].
Cycling Economy (CE)	The metabolic cost (VO_2) required to maintain a given submaximal power output.	Explains performance differences in cyclists with similar VO_2max; improved through training and technique [7].
Peak Power Output (PPO)	The highest power output achieved in a short, maximal test (e.g., 5-sec to 1-min).	Critical for sprinting, attacks, hill climbs, and track events like the Keirin [15].
Critical Power (CP)	The theoretical power output that can be sustained indefinitely without fatigue.	Represents the upper boundary of the heavy-intensity domain; a key marker of aerobic endurance [17].
W' (W Prime)	The finite amount of work that can be done above Critical Power.	Represents anaerobic capacity/reserve; crucial for repeated surges and efforts above threshold [16].
Heart Rate Variability (HRV)	The variation in time between heartbeats, indicating autonomic nervous system balance.	Used as a non-invasive marker of training stress, recovery status, and readiness to perform [18].

3.3.1. Aerobic Power and Capacity

The literature consistently identifies a core triad of aerobic parameters: **VO_2max:** Cited in 98% of the primary research studies, VO_2max was universally acknowledged as a foundational requirement for elite performance. However, numerous studies emphasized its limitation: among a homogenous group of elite cyclists, VO_2max values plateau and are poor predictors of performance differences, as other factors become more critical [14]. **Lactate Threshold (LT) and Maximal Lactate Steady State (MLSS):** These thresholds were highlighted in 85% of studies as being more sensitive than VO_2max for predicting endurance performance. The power output or velocity at these thresholds (often termed Functional Threshold Power or FTP) was repeatedly shown to be the best single predictor of time-trial performance [6]. **Cycling Economy (CE):** Approximately 60% of studies that measured CE demonstrated that at any given submaximal intensity, cyclists with better economy (a lower VO_2) could perform more efficiently, preserving glycogen stores and delaying fatigue, thereby directly enhancing endurance capacity [7].

3.3.2. Neuromuscular and Anaerobic Power

This theme encompasses parameters crucial for high-intensity efforts: **Maximal Power / Peak Power Output (PPO):** Particularly in studies focusing on track sprinters, road sprinters, and during simulated attacks, PPO was a definitive performance determinant. It is highly dependent on muscle fiber type, strength, and neuromuscular coordination [15]. **Fatigue Resistance / W' (W Prime):** The concept of W', as part of the Critical Power model, was featured in 30% of the more recent studies (post-2010). It was identified as a key differentiator in events requiring repeated surges, such as a criterium race or a mountainous road race, where the ability to recover and replenish W' between efforts is critical [16].

3.3.3. Integrated and Emerging Parameters

The mapping shows an evolution towards more holistic and monitoring-based metrics: **Critical Power (CP):** The CP model, comprising CP and W', was presented in several reviews as a robust framework for understanding the entire power-duration relationship, from seconds to hours, providing a comprehensive physiological profile [17]. **Heart Rate Variability (HRV):** While not a direct performance *determinant* like VO_2max, HRV was identified in longitudinal studies as a valuable *monitoring tool*. It is used to assess an athlete's adaptation to training, with reductions in HRV often correlating with overreaching and impaired performance [18].

4. DISCUSSION

This scoping review set out to map the key physiological determinants of cycling performance and to identify the specific evidence available for Indian cyclists. The primary finding is a clear consensus on a core set of physiological parameters that govern performance, set against a near-total absence of population-specific data for Indian athletes. This discussion synthesizes these findings, identifies critical gaps in the literature, acknowledges the limitations of this review, and outlines implications for both practice and future research.

4.1 Interpretation of findings

The literature consistently identifies a triad of physiological parameters as the primary determinants of cycling performance: VO_2max, Lactate Threshold (LT), encompassing its various conceptualizations such as Functional Threshold Power (FTP) or Maximal Lactate Steady State (MLSS) and Cycling Economy (CE) or Efficiency. VO_2max represents the upper ceiling of an athlete's aerobic capacity and is a foundational requirement for elite performance. However, among homogenous groups of highly trained cyclists, its power to discriminate performance diminishes, and other factors become more critical. The power output at the Lactate Threshold (LT or FTP) emerges as a more sensitive predictor, directly indicating the highest sustainable intensity for prolonged periods, such as during a time-trial. Meanwhile, Cycling Economy explains performance differences in athletes with similar VO_2 max values, as a lower metabolic cost for a given submaximal power output preserves glycogen stores and delays fatigue [19-20].

Beyond this central triad, the findings highlight the critical role of neuromuscular and strength parameters. Recent evidence demonstrates that cycling isokinetic peak force (cIPF) at moderate to high cadences (e.g., 80 and 120 rpm) can explain a significant portion of the variability in power output at both ventilatory thresholds and maximal aerobic power. This underscores that strength is not just for sprinters but is integral to aerobic endurance performance. Furthermore, the gross mechanical efficiency has been shown to improve following targeted training camps, correlating with enhanced power output. [21-23].

Perhaps the most crucial synthesis from this review is that these physiological determinants do not operate in isolation. They form a complex, integrated system and are modulated by other dimensions of performance. As outlined by a comprehensive review of elite competition, performance is constrained by a framework that includes not only the Individual dimension (physiology, morphology, psychology) but also the Tactical (e.g., drafting, team dynamics), Strategic (e.g., race format, terrain), and (e.g., socio-economic factors) dimensions. For instance, a cyclist's physiological capability is merely potential; its effective application in a mass-start race depends on tactical intelligence to optimize energy expenditure and strategic adaptation to course profiles. This multi-dimensional interplay explains why laboratory-measured physiological variables alone may only account for a limited percentage (e.g., ~40%) of performance variance in actual competition [24-27].

Table 4: Summary of Key Physiological Determinants and Their Interactions

Physiological Determinant	Primary Role	Interaction with Other Dimensions
VO_2max	Sets aerobic power ceiling	Necessary foundation, but insufficient for success in tactical races.
Lactate Threshold (FTP)	Defines sustainable race pace	Pacing strategy is based on this metric; terrain and drafting can alter the perceived exertion at this intensity.
Cycling Economy/Efficiency	Determines metabolic cost of submaximal power	Improved economy preserves glycogen for decisive tactical efforts later in a race.
Neuromuscular Power (cIPF)	Influences power output at threshold and supra-threshold intensities	Critical for attacks, sprints, and technical terrain requiring rapid power changes.
Training Intensity Distribution (e.g., Polarized Model)	Organizes training stimulus to maximize adaptation	The 80/15/5 (low/threshold/high) model is a strategic framework to balance adaptation and recovery.

4.2 Gaps in the Literature

This review has identified several significant gaps in the current research landscape.

A) Population Gaps: The most striking finding is the **profound lack of research on Indian cyclists**. Our systematic search failed to identify a single study focused on this demographic. The existing literature is overwhelmingly populated by data from Caucasian athletes in Europe, North America, and Australia. This creates a substantial evidence gap, as genetic, dietary, environmental, and training-cultural factors could influence physiological profiles and responses to training. Furthermore, there is a notable under-representation of **female cyclists, master cyclists, and Paralympic cyclists** across all geographies. [27-28].

B) Conceptual Gaps: Several conceptual areas are underexplored. First, there is a disconnect between the reductionist, laboratory-based study of physiology and the complex, dynamic reality of competitive racing. Second, as identified in a survey of track cycling practitioners, scientific evidence for **Tactics and Mental Skills** is perceived as lacking, leading to a heavy reliance on personal experience rather than evidence-based practice. Third, the physiological demands of **technical disciplines**, such as MTB descent or BMX, are not as well understood as those of road cycling and time-trials. [20,29-30].

C) Methodological Gaps: A key methodological gap is the over-reliance on laboratory testing versus integrated field-based monitoring. While lab tests provide controlled data, they may not fully capture the physiological demands of actual racing. Furthermore, there is a need for greater standardization in methodologies, such as bicycle set-up measurements and kinematic data collection, to improve the reproducibility and comparability of future studies. [24-31].

4.3 Limitations

This scoping review has several limitations that should be acknowledged. First, the broad scope across cycling disciplines and physiological parameters precluded quantitative synthesis, and the findings therefore provide a descriptive map of existing evidence rather than an assessment of the strength of associations. Second, the search was restricted to English-language, peer-reviewed publications, introducing potential language and publication bias and possibly omitting relevant grey literature, including locally disseminated Indian studies. Third, in line with scoping review methodology, no formal assessment of methodological quality was undertaken; consequently, the findings reflect the breadth of available literature and not a weighted evaluation of evidence rigor. Finally, despite a comprehensive search strategy, some relevant studies may have been missed due to database coverage or the use of non-standard terminology for key physiological metrics.

4.4 Implications for Practice and Future Research

4.4.1 Implications for Practice:

For Coaches and Athletes, the evidence strongly supports a holistic assessment of cyclists that goes beyond VO_2max. Performance profiling should routinely include Lactate Threshold, Cycling Economy, and sport-specific strength (cIPF) assessments. Training programs should consider adopting a polarized intensity distribution (~80% low intensity, ~15-20% high intensity), which has demonstrated superior efficacy in improving key endurance markers.

For Practitioners working with Indian cyclists, given the absence of population-specific norms, coaches and sports scientists working with Indian cyclists must cautiously apply international benchmarks. There is an urgent need to establish local normative data through systematic physiological profiling of developing and elite athletes. This will enable the creation of culturally and genetically relevant training frameworks.

4.4.2 Implications for Future Research:

For addressing the population gaps, the highest priority should be given to initiating longitudinal physiological profiling studies of Indian cyclists. This should include athletes across disciplines (road, track, MTB), performance levels, genders, and age groups to build a comprehensive database.

Future research should address conceptual gap and employ more ecological study designs that integrate physiological, tactical, and psychological monitoring in real-world competition settings. Research should also focus on the under-studied domains of Mental Skills and technical cycling disciplines.

From a methodological perspective the researchers should adhere to the emerging standardized guidelines for bicycle fitting and kinematic assessment to improve data consistency. There is also a need to develop and validate more practical, field-based methods for monitoring key physiological parameters like the aerobic threshold outside the laboratory.

In conclusion, while the physiological determinants of cycling performance are well-established in the global literature, their application is not universal. The stark absence of data on Indian cyclists represents both a critical gap in scientific knowledge and a significant opportunity. Filling this gap is essential for optimizing the development and performance of Indian cyclists on the world stage.

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