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An Overview on Maximal Aerobic Speed: Assessment Methodologies and Practical Applications

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Reeshabh Tanti
PhD Scholar, Lakshmibai National Institute of Physical Education (LNIPE), N.E.R.C., Guwahati, Assam, India
Dr. Ramesh Chand Yadav
Assistant Professor, Lakshmibai National Institute of Physical Education (LNIPE), N.E.R.C., Guwahati, Assam, India

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Abstract

Maximal Aerobic Speed (MAS), which can be defined as the lowest speed at which VO2max occurs, bridges the gap between laboratory gas analysis and applied athlete conditioning. This narrative review examines the methodological determination of MAS across laboratory and field settings, evaluating its advantages and critical limitations. MAS provides an objective, running economy-adjusted metric that standardizes physiological load, simplifies large sample testing, and refines high-intensity training prescriptions. However, practitioners must account for its key limitations. When integrated with biomechanical and anaerobic considerations, MAS serves as a robust, scalable framework for optimizing cardiorespiratory fitness and training load monitoring.

Keywords: Maximal Aerobic Speed (MAS), VO2max, training, training load, performance monitoring.

Introduction

In the current scenario of performance monitoring, VO2 max plays a crucial role as a physiological performance indicator. VO2 max is the maximum amount of oxygen that can be used up by the body under conditions of physical stress. Alongside VO2 max, another more detailed means for monitoring cardiorespiratory fitness is the Maximal Aerobic Capacity

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(MAS), which is also known as Velocity at VO2 max (vVO2 max), when it is tested in a laboratory setting.

Maximal Aerobic Capacity (MAS) can be described as the lowest intensity, or the lowest running speed at which VO2 max occurs.

Researchers often refer to Maximal Aerobic Speed (MAS) as a practical and time-effective way to assess the aerobic energy system of team sport athletes, as the Velocity at VO2max (vVO2max) derived from treadmill testing with gas analysis can be impractical for team sports to administer due to cost, time, and equipment required (Baker & Heaney, 2015). The main purpose of developing Maximal Aerobic Speed was to increase training specificity and to monitor training loads more efficiently.

This article used a narrative review format to provide an overview to determine Maximal Aerobic Speed, the benefits, and the limitations.

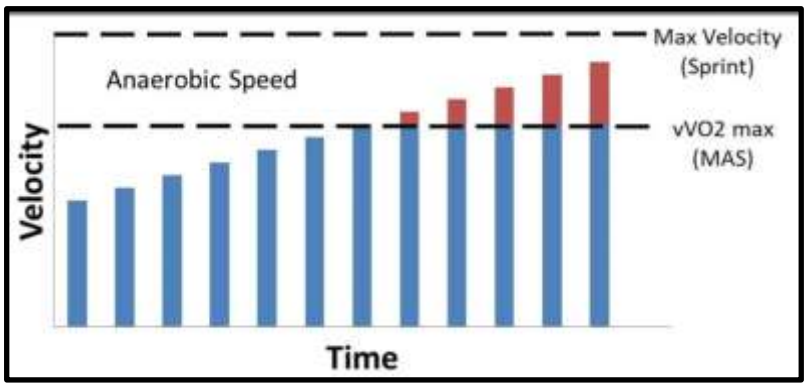


Fig 1: Conceptual representation of MAS and Anaerobic Speed Reserve.

Determination of Maximal Aerobic Speed

1. Laboratory Treadmill Protocols

Determination of MAS through a laboratory treadmill uses similar methodology as such in the determination of VO2 max. Through ergometry, the metabolic gaseous exchange of the subjects needs to be monitored. The VO2 max of the subjects can be directly monitored in this particular test through indirect calorimetry, and that plays a vital role in the analysis. The subjects start on the treadmill at a steady velocity, followed by a step increment in the ramp velocity (increment of 0.5km/h to 1.0km/h, in an interval of 2 ± 1 minute, to monitor the blood lactate thresholds). Previous research indicates that there is a positive correlation between VO2 max and blood lactate; (Burke et al., 1994) suggested that aerobic interval training produces

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similar changes in VO2max, lactate, and ventilatory thresholds and that these changes appear to be independent of the length of the work interval. During the protocol, the lowest speed of the ramp at which the plateau of VO2 initiation is observed (despite increasing the intensity) is considered to be the Maximal Aerobic Speed of the subject.

2. 5 Minute Time Trial (5MTT)

Although laboratory testing provides valuable and precise insights on the physiological parameters, field-based testing may more prominently replicate the original environment of the activity (Buchheit and Laursen, 2013). Field-based testings are also cost-effective and less time-consuming compared to laboratory-based tests. Field-based physiological tests provide valuable information about an athlete within an ecologically valid environment (Smith et al., 2025).

5 Minute Time Trial (5MTT) is a field-based test to assess maximal aerobic speed (MAS). It was developed by (Berthon et al., 1997), using a theoretical approach of previous world record data, it was calculated that the most suitable duration to measure MAS in a field-based test setting was 5 minutes. A study conducted by (Berthon et al., 1997), suggested a strong correlation of 0.94 (r=0.94) in the measurement of MAS between laboratory-based treadmill protocols and 5MTT. Research indicates that field tests that estimate maximal aerobic speed play an essential role in assessing aerobic fitness (Park et al., 2025).

The procedure for 5MTT involves a proper pacing guide. Within the guided pace, the athlete covers the maximum distance attainable in 5 minutes. The maximal aerobic speed is estimated using the following equation:

[MAS=Total distance covered in meters/300].

3. Vitesse Aérobie Maximale - Évaluation (VAM-EVAL)

The Vitesse Aérobic Maximale-Évaluation test (VAM-EVAL) is a modified version of the University of Montreal Track Test (UMTT), which was developed in 1980 to assess VO2max (Bok & Foster, 2021). This test is used to assess the MAS of the athletes; however, research conducted by (Bok & Foster, 2021) suggests that VAM-EVAL and UMTT are the best field-based tests to determine the maximal oxygen uptake (VO2max). VAM-EVAL was developed by Georges Cazorla and Luc Leger in 1993.

For the purpose of conducting the VAM-EVAL test, specifically 400m running track is necessary. Visible cones/markers are to be placed 20m apart. The pacing, which is maintained

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by audio tracks, initiates at the speed of 8.0km/h. The pacing is progressively increased by 0.5km/h, every 1 minute. The last speed at which the subject fails to match the audio beep at a designated cone/marker placed every 20m by 2m or more consecutively twice is considered the MAS.

Protocol	Modality	Primary Metric Derived	Advantages	Limitations
Laboratory Ramp Test	Treadmill + Indirect Calorimetry	vV02max	Higher accuracy on physiological metrics, simultaneous blood lactate, metabolic gas exchange profiling.	High cost, time-consuming for larger sample size, lesser field ecological validity.
5 MTT	Outdoor Track/Pitch	Average Velocity	Minimal equipment required, cost-efficient, time-efficient for larger sample size.	Improper pacing can impact outcome.
VAM-EVAL	Incremental Linear Track	Peak Linear Velocity	Elimination of pacing error due to standardised pace guidance, high correlation with laboratory ramp test.	Requires calibrated audio technology.

Table 1: Overview of the methodologies to assess Maximal Aerobic Speed (MAS).

Benefits

1. Accurate prescription of Metabolic Conditioning: Eliminates arbitrary distance or time goals. Standardized prescription of intervals guarantees a consistent

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physiological load on the entire squad, despite variations in baseline fitness levels from MAS.

2. Efficiency in Testing Large Teams: Field protocols like 5MTT and VAM-EVAL allow simultaneous testing of 20 to 50 athletes in less than 30 minutes, minimizing scheduling conflicts during pre-season preparations and being more efficient with the time.

3. Integration of Physiological and Biomechanical data: A clear advantage over heart rate (cardiovascular drift and lag during short intervals) or blood lactate (invasive sampling) is that MAS offers an immediate external locomotion target (m/sec or km/hr) which incorporates with the running economy.

4. Adaptability to Various Conditioning Formats: MAS is easily synchronized over long periods, short micro-intervals (e.g., 15s:15s), and grid/box topologies, Eurofit method.

Limitations

1. Neglects the Anaerobic Speed Reserve (ASR): Maximal Aerobic Speed (MAS) reflects only aerobic capacity. At supramaximal speeds, athletes with high maximal sprint velocities will be working at a much smaller percentage of their total capacity than endurance-dominant, low-speed athletes. These athletes would therefore fatigue at vastly different rates when prescribed the same workload

2. Discrepancy Between Linear and Multi-Directional Demands: Linear MAS does not reflect the energy and mechanical costs associated with changes of direction (COD), accelerations, and decelerations imposed by the sport.

3. Failure to Reflect Submaximal Threshold Adaptations: Athletes could present with identical MAS yet differ considerably in their ventilatory threshold or lactate threshold. This is important because the ability to sustain high percentages of one's MAS for prolonged time periods is governed by the lactate threshold

4. Environmental and Surface Sensitivity: Field-derived MAS could be influenced by wind, temperature, surface conditions, and footwear amongst other factors.

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Conclusion

MAS can be used as a practical and efficient method to analyse the aerobic capacity for the purpose of individualised training prescription and grouping of athletes. Specifically, the field-based tests (5MTT and VAM-EVAL) are cost- and time-efficient compared to other sophisticated cardiovascular tests. Training facilitation based on the insights gained by MAS can result in significant improvement in aerobic functioning.

However, its limitations, specifically that it doesn't account for the Anaerobic Speed Reserve and multi-directional demands, should be taken into consideration.

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