IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 1, July 2026
Impact Factor: 8.2

Relationship between Aerobic Capacity, Anaerobic Power and Motor Fitness Performance among Competitive Athletes of Rajasthan

Ganga Sahay Yadav[1] and Dr. Ganga Shyam Gurjar[2]
[1]Research Scholar, Department of Physical Education
[2]Research Guide, Department of Physical Education
Shri Jain Teachers Training College, Alwar

Abstract: *Physical performance in competitive sport is determined by the integrated contribution of aerobic capacity, anaerobic power and motor fitness. Aerobic capacity supports sustained exercise and recovery between repeated efforts, whereas anaerobic power contributes to rapid, high-intensity actions such as sprinting, jumping, accelerating and throwing. Motor fitness includes task-related abilities such as speed, agility, coordination, balance, flexibility and muscular strength. The present paper proposes an analytical investigation of the relationship among these variables in competitive athletes of Rajasthan.*

A quantitative, cross-sectional correlational design is proposed for athletes aged 18–25 years registered with recognised clubs, academies, colleges or district/state-level sporting bodies. Aerobic capacity may be assessed through a graded exercise test with direct measurement of maximal oxygen uptake (VO_2max), or through a validated field estimate such as the 20-m shuttle-run test. Anaerobic power may be measured using a 30-second Wingate test, while motor fitness may be assessed through a standardised battery including sprint, standing broad jump, agility, flexibility, strength and balance tests..

Keywords: aerobic capacity, anaerobic power, motor fitness, competitive athletes, VO_2max, Wingate test

I. INTRODUCTION

Competitive sports require athletes to perform a wide range of physical actions under changing physiological and environmental demands. Endurance events depend heavily on the ability to transport and utilise oxygen, while sprinting, jumping, rapid changes of direction and explosive technical actions require high rates of energy production over short periods. Many sports combine both demands. Consequently, the physical profile of a competitive athlete cannot be understood through a single fitness indicator. Cardiorespiratory fitness, muscular fitness and neuromotor abilities represent interconnected dimensions of physical fitness (American College of Sports Medicine, 2025).

Aerobic capacity refers to the integrated ability of the respiratory, cardiovascular and muscular systems to take up, transport and utilise oxygen during sustained physical activity. Maximal oxygen uptake (VO_2max) is commonly used as an indicator of the upper limit of aerobic capacity and is usually expressed relative to body mass as $mL \cdot kg^{-1} \cdot min^{-1}$. Higher aerobic capacity can support prolonged exercise and may assist recovery during repeated high-intensity efforts. Field tests such as the 20-m shuttle run are often used when laboratory gas-analysis equipment is unavailable. A systematic review found strong evidence for the validity of the 20-m shuttle run and several distance-based tests for estimating cardiorespiratory fitness in adults (Bennie et al., 2021).

Anaerobic power is the capacity to produce energy rapidly without relying predominantly on oxidative metabolism. It is important during short-duration maximal or near-maximal activities, including acceleration, sprinting, jumping and explosive changes of direction. The Wingate anaerobic test is a widely used cycle-ergometer protocol that measures peak power, mean power and the decline in power output during a 30-second maximal effort.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 1, July 2026 Impact Factor: 8.2

However, test outcomes should be interpreted in relation to body mass, sex, sport demands and familiarity with cycling-based exercise. Research involving CrossFit participants has reported that aerobic capacity and anaerobic power can both contribute to performance in some high-intensity tasks, although the contribution varies with the nature of the task and competitive experience (Bellar et al., 2015).

Motor fitness refers to the physical capacities that enable efficient, controlled and purposeful movement. In sport settings, relevant components commonly include speed, agility, coordination, balance, flexibility, muscular strength, muscular endurance and explosive power.

The relative importance of each component differs across sports. For example, a sprinter may require exceptional acceleration and lower-body power, whereas a badminton player may place greater demands on agility, reaction, balance and repeated intermittent movement. Standardised field tests can provide practical information, but test selection must match the construct being assessed. Evidence reviews indicate that selected field tests have useful reliability and validity, while the quality of evidence differs between tests and outcomes (Bennie et al., 2021; Stricker et al., 2022).

Rajasthan has a varied competitive sports environment, including athletics, wrestling, kabaddi, football, volleyball, basketball, hockey, cricket and other individual and team sports. Athletes train under different coaching systems, facilities, seasonal conditions and competition schedules. Such variation makes it important to examine physiological and motor fitness variables together rather than treating them as isolated capacities. A systematic assessment may help identify whether athletes with higher aerobic capacity also tend to demonstrate greater anaerobic power or better motor fitness, and whether these relationships differ by sport category or sex.

The present research focuses on the association between aerobic capacity, anaerobic power and motor fitness performance among competitive athletes of Rajasthan. It is correlational rather than experimental: it seeks to establish the strength and direction of relationships and does not assume that one fitness component directly causes improvement in another. The study framework also recognises that training age, body composition, sport-specific demands and competitive level may influence observed associations.

REVIEW OF RELATED LITERATURE

Bellar et al., (2015) examined the relationship of aerobic capacity, anaerobic peak power and experience to performance in CrossFit exercise. Their findings indicated that VO_2max and anaerobic power were significant predictors of performance in one workout, while experience was the significant predictor in another. This suggests that physiological predictors are task-dependent and that training experience should be considered when analysing athletic performance.

Bennie et al., (2021) reviewed the criterion-related validity of field-based fitness tests in adults. Their review identified strong evidence supporting the validity of the 20-m shuttle run and several distance or walking tests for estimating cardiorespiratory fitness. It also identified the handgrip test as a valid measure of maximal isometric hand strength. The review cautioned that some commonly used flexibility tests do not necessarily measure the intended anatomical construct accurately.

Petrova (2021) investigated relationships between aerobic and anaerobic cardiopulmonary indices in young male soccer players during laboratory functional tests. The work illustrates the value of examining both energy-system characteristics in sport-specific populations. Research on physiological predictors of CrossFit competition has also shown that jump ability, Wingate power and VO_2max can be associated with overall performance, while the relative contribution of each marker may vary across tasks.

Stricker et al., (2022) reviewed the reliability of field-based fitness tests in adults. Their findings supported the reliability of selected cardiorespiratory and musculoskeletal tests, while evidence for some motor fitness measures was more variable. This reinforces the importance of standardised instructions, familiarisation, consistent equipment and trained assessors.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 1, July 2026 Impact Factor: 8.2

Taken together, the literature supports the assessment of aerobic and anaerobic capacities alongside sport-relevant motor abilities. However, findings from one sport or country cannot automatically be generalised to all competitive athletes in Rajasthan. A regionally focused study using a consistent test protocol and appropriate statistical controls can add useful evidence.

STATEMENT OF THE PROBLEM

The problem addressed in this study is to determine the nature and extent of the relationship between aerobic capacity, anaerobic power and motor fitness performance among competitive athletes of Rajasthan, and to examine whether these relationships remain evident after accounting for selected demographic and sport-related characteristics.

RESEARCH METHODOLOGY

1. Research Design

A quantitative, cross-sectional correlational research design is proposed. All measurements will be collected within a defined assessment period under standardised conditions. The design is suitable for examining associations among naturally occurring fitness characteristics; it does not establish causality.

2. Population and Sample

The target population will comprise competitive athletes from Rajasthan who participate in organised training and competitions through recognised sports clubs, academies, colleges, universities, district associations or state-level bodies. A proposed sample of 200 athletes (approximately 100 male and 100 female, where recruitment permits) may be selected using stratified sampling across sport categories. The final sample size should be confirmed through an a priori power analysis based on the smallest correlation considered practically important, desired statistical power (commonly .80 or higher), alpha level (.05) and anticipated non-response.

3. Inclusion and Exclusion Criteria

Inclusion criteria: (a) athletes aged 18–25 years; (b) currently engaged in organised competitive training; (c) at least two years of regular sport-specific training; (d) participation in district-, state-, university- or national-level competition within the preceding two years; and (e) provision of written informed consent.

Exclusion criteria: current injury or illness that makes maximal testing unsafe; known medical contraindication to vigorous exercise; or inability to complete the assessment protocol. Medical screening and appropriate supervision should precede maximal exercise testing.

4. Variables and Operational Definitions

Variable	Operational definition	Suggested measure / unit
Aerobic capacity	Maximum or estimated capacity to take up and utilise oxygen during exercise	VO_2max ($mL \cdot kg^{-1} \cdot min^{-1}$); graded treadmill/cycle test with gas analysis, or 20-m shuttle-run estimate
Anaerobic power	Peak and average mechanical power during a brief maximal effort	30-s Wingate test: peak power (W and $W \cdot kg^{-1}$), mean power (W and $W \cdot kg^{-1}$), fatigue index (%)
Speed	Ability to cover a short distance rapidly	30-m sprint time (seconds)
Agility	Ability to change direction rapidly while maintaining control	T-test or 5-10-5 shuttle time (seconds)
Explosive leg power	Ability to produce high force rapidly with the lower limbs	Standing broad jump distance (cm)
Upper-body strength	Maximal isometric handgrip force	Handgrip dynamometer (kg)
Flexibility	Range of movement assessed using a defined protocol	Use a joint-specific protocol; report test and unit
Balance	Ability to maintain postural stability	Standardised single-leg stance or validated

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 1, July 2026
Impact Factor: 8.2

		balance test

5. Tools and Testing Protocol

Aerobic capacity: The preferred laboratory option is a graded exercise test to volitional exhaustion using a calibrated treadmill or cycle ergometer with breath-by-breath gas analysis. VO_2max criteria and termination procedures should follow the laboratory's recognised exercise-testing standards. If laboratory testing is not feasible, a 20-m shuttle-run test may be used to estimate aerobic fitness; the paper must clearly report that the outcome is an estimate rather than directly measured VO_2max.

Anaerobic power: A 30-second Wingate test may be conducted on an electronically braked cycle ergometer using a consistent resistance protocol appropriate to participant body mass and the laboratory's validated procedure. Record peak power, mean power and fatigue index. Provide a familiarisation session and standardise warm-up, seat height, verbal encouragement and recovery.

Motor fitness: A practical battery may include a 30-m sprint for speed, T-test for agility, standing broad jump for lower-body explosive power, handgrip dynamometry for upper-body isometric strength, a joint-specific flexibility assessment and a standardised balance test. The same test order, surface, footwear requirements, warm-up and rest intervals should be used for all participants. Reliability evidence supports several field-based tests, but the selected protocol and its limitations must be stated (Bennie et al., 2021; Stricker et al., 2022).

6. Data Collection Procedure

After institutional and relevant sports-authority permissions are obtained, eligible athletes will be informed about the study purpose, procedures, potential risks and right to withdraw. Written consent will be obtained. Demographic and sport-participation details will be recorded, including age, sex, height, body mass, sport, competitive level, years of training, weekly training volume and recent injury history. Participants will be asked to avoid strenuous training for an agreed recovery period before testing and to follow consistent pre-test instructions regarding food, hydration, caffeine and sleep. Testing should be scheduled at a similar time of day where possible. A trained team will supervise assessments, record results immediately and maintain coded, confidential records.

7. Statistical Analysis

Data will be checked for missing values, outliers, distributional assumptions and test-protocol deviations. Descriptive statistics (mean, standard deviation, minimum and maximum) will summarise participant characteristics and fitness outcomes. Pearson's product–moment correlation will be used when assumptions are met; Spearman's rank correlation will be considered for non-normal or ordinal data. Partial correlations may control for age, sex and body mass. Multiple linear regression may examine whether aerobic capacity and anaerobic power predict motor fitness outcomes after adjustment for sport category, training experience and other prespecified covariates. Report effect sizes, 95% confidence intervals and exact p values; statistical significance may be set at $p < .05$. Where multiple correlations are tested, an appropriate adjustment or clearly defined primary outcomes should be used.

RESULTS

Important reporting note: The following tables are blank reporting formats. They must be populated with the actual measurements collected from the selected athletes. No numerical findings are claimed in this paper.

Table 1. Demographic and Sport-Related Profile of Participants

Characteristics	Category / statistic	n	% / Mean ± SD
Age (years)	Mean ± SD	—	—
Sex	Male	—	—
	Female	—	—
Sport category	Individual sports	—	—

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 1, July 2026 Impact Factor: 8.2

	Team sports	—	—
Competitive level	District	—	—
	State / University	—	—
	National	—	—
Training experience (years)	Mean ± SD	—	—

Table 2. Descriptive Statistics of Aerobic Capacity, Anaerobic Power and Motor Fitness

Variable	Unit	N	Mean	SD	Minimum	Maximum
VO_2max / estimated VO_2max	$mL \cdot kg^{-1} \cdot min^{-1}$	—	—	—	—	—
Wingate peak power	W	—	—	—	—	—
Wingate relative peak power	$W \cdot kg^{-1}$	—	—	—	—	—
Wingate mean power	W	—	—	—	—	—
Wingate fatigue index	%	—	—	—	—	—
30-m sprint	s	—	—	—	—	—
T-test agility	s	—	—	—	—	—
Standing broad jump	cm	—	—	—	—	—
Handgrip strength	kg	—	—	—	—	—
Flexibility measure	protocol-specific	—	—	—	—	—
Balance measure	protocol-specific	—	—	—	—	—

Table 3. Correlation Matrix among Primary Study Variables

Variables	1	2	3	4	5	6
1. Aerobic capacity	—					
2. Anaerobic peak power		—				
3. Anaerobic mean power			—			
4. Sprint performance				—		
5. Agility performance					—	
6. Explosive leg power						—

Note. Enter Pearson's r (or Spearman's rho where appropriate) in the relevant cells. For timed outcomes, lower values represent better performance; interpret the sign of correlations accordingly. Add p values or significance markers and 95% confidence intervals in the final manuscript.

Table 4. Multiple Regression Model for Motor Fitness Performance

Predictor	B	SE B	β	t	p	95% CI
Aerobic capacity	—	—	—	—	—	—
Anaerobic peak power	—	—	—	—	—	—
Age	—	—	—	—	—	—

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 1, July 2026 Impact Factor: 8.2

Sex	—	—	—	—	—	—
Training experience	—	—	—	—	—	—
Sport category	—	—	—	—	—	—

Model summary to report: R^2 = —; adjusted R^2 = —; F(df1, df2) = —; p = —. Define the dependent variable clearly. If a composite motor fitness score is created, explain how different units and directions were standardised before aggregation.

DISCUSSION

The discussion should be written after the tables have been populated with observed data. The first objective is to describe the aerobic-capacity profile of the athletes and compare it cautiously with published findings from athletes of similar age, sex and sport. Differences in test modality, body-mass normalisation, training phase and competitive level can influence comparisons. Directly measured VO_2max and field-estimated aerobic capacity should not be treated as interchangeable outcomes.

The second focus is the association between aerobic capacity and anaerobic power. These capacities are physiologically distinct but may coexist at relatively high levels in athletes exposed to repeated high-intensity efforts. A positive association would not mean that aerobic capacity causes greater peak anaerobic power; shared influences such as training history, sport selection, body composition and overall conditioning may contribute. The task-specific findings reported by Bellar et al. (2015) illustrate why relationships should be interpreted in the context of the sport and performance task.

The third focus is the relationship of both energy-system variables with motor fitness. Aerobic capacity may be more closely related to repeated-effort tolerance and recovery, while anaerobic power may be more directly associated with explosive actions such as jumping and short sprinting. Agility, balance and coordination are complex abilities and may depend strongly on technical practice, perceptual skill and sport-specific experience. Therefore, correlations are expected to differ across individual motor tests rather than produce one uniform pattern.

If the relationships differ across sport categories, this may reflect the different physiological and technical demands of endurance, sprint-power, combat and team sports. Sex, age, body mass and training experience should be considered as potential confounders. Coaches should avoid using a single fitness test to rank athletes across unrelated sports. Instead, assessment should be aligned with sport-specific performance demands and interpreted alongside technical and tactical performance.

The study's practical contribution will depend on measurement quality. Standardised protocols, familiarisation, calibrated equipment and consistent environmental conditions are essential. The literature indicates that some field tests have stronger validity or reliability evidence than others, which should guide test selection and interpretation (Bennie et al., 2021; Stricker et al., 2022).

II. CONCLUSION

Aerobic capacity, anaerobic power and motor fitness are complementary dimensions of competitive athletic performance. Their relative importance varies according to sport-specific demands, and the relationship among them should be examined using reliable tests and appropriate statistical controls. The proposed study provides a structured framework for investigating these associations among competitive athletes of Rajasthan. Once actual data are collected and analysed, the findings may support evidence-informed conditioning, athlete profiling and individualised training. Until then, the blank result tables should remain unfilled rather than being replaced with fabricated statistics.

REFERENCES

1. American College of Sports Medicine. (2025). The components of physical fitness: A roundtable statement by the American College of Sports Medicine. *Medicine & Science in Sports & Exercise*, 58(8), 1827–1850.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 1, July 2026
Impact Factor: 8.2

2. Bellar, D., Hatchett, A., Judge, L. W., Breaux, M. E., & Marcus, L. (2015). The relationship of aerobic capacity, anaerobic peak power and experience to performance in CrossFit exercise. *Biology of Sport*, 32(4), 315–320.
3. Bennie, J. A. (2021). Criterion-related validity of field-based fitness tests in adults: A systematic review. *Journal of Clinical Medicine,* 10(16), 3743.
4. Mangine, G. T. (2020). Physiological predictors of competition performance in CrossFit athletes. *International Journal of Environmental Research and Public Health*, 17(10), 3699.
5. Petrova, B. (2021). Relationships between aerobic and anaerobic cardiopulmonary indices of young male soccer players when performing laboratory functional tests. *Journal of Applied Sports Sciences*, 2, 40–50.
6. Stricker, P. R., (2022). Reliability of field-based fitness tests in adults: A systematic review.