**Proximus Journal of Sports Science and Physical Education**
Volume 3, Issue 11, November 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

# SPECIFIC FEATURES OF DIAGNOSING CARDIOVASCULAR OVERFATIGUE IN ATHLETES ENGAGED IN CYCLIC SPORTS

**Sogdiana Sabitjanovna Abdusattarova**
Associate Professor, Department of Medical and Biological Sciences
Uzbekistan State University of Physical Education and Sport
Email: sogdianaabdusattarova81@gmail.com
**Dilfuza Kenjayevna Ramanova**
Senior Lecturer, Department of Medical and Biological Sciences
Uzbekistan State University of Physical Education and Sport
Email: dilramanova@gmail.com

**Abstract.** The diagnosis of cardiovascular overfatigue in athletes engaged in cyclic sports is an important aspect of sports medicine and the monitoring of physical performance. Athletes involved in running, swimming, cycling, rowing, and cross-country skiing are exposed to prolonged and repetitive physical loads that place considerable demands on the cardiovascular system. Although regular endurance training produces beneficial physiological adaptations, excessive training loads combined with inadequate recovery may result in functional disturbances, persistent fatigue, and reduced athletic performance. This article examines the specific features of diagnosing cardiovascular overfatigue in athletes participating in cyclic sports. Particular attention is given to clinical assessment, electrocardiography (ECG), echocardiography, exercise stress testing, heart rate variability (HRV), and laboratory investigations. The article also discusses the importance of distinguishing physiological cardiac adaptations associated with athletic training from pathological cardiovascular conditions.

**Keywords:** cardiovascular overfatigue, cyclic sports, endurance athletes, electrocardiography, echocardiography, heart rate variability, exercise stress testing, sports medicine, overtraining syndrome, cardiovascular monitoring.

## INTRODUCTION

Modern competitive sport is characterized by increasing training volumes, high-intensity exercise sessions, and demanding competition schedules. These factors are particularly relevant to cyclic sports, including long-distance running, swimming, cycling, rowing, and cross-country skiing. Athletes in these disciplines perform repetitive movements over extended periods, requiring continuous and efficient functioning of the cardiovascular and respiratory systems.

The cardiovascular system plays a central role in maintaining physical performance. It ensures the delivery of oxygen and nutrients to working muscles, supports the removal of metabolic by-products, and regulates body temperature during exercise. In response to systematic endurance training, the heart and circulatory system undergo physiological adaptations, including increased stroke volume, improved cardiac efficiency, and changes in resting heart rate.

However, when the intensity and volume of training exceed the body's adaptive capacity, especially in the absence of sufficient recovery, athletes may develop persistent fatigue and a decline in performance. Such conditions require careful assessment because symptoms of overreaching and overtraining may overlap with manifestations of cardiovascular diseases.

It is important to distinguish cardiovascular fatigue associated with excessive training from pathological cardiovascular conditions. A reduced resting heart rate or an enlarged cardiac chamber may

**Proximus Journal of Sports Science and Physical Education**
Volume 3, Issue 11, November 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

represent normal athletic adaptation, whereas unexplained exercise intolerance, abnormal arrhythmias, chest discomfort, or an unusual decline in exercise capacity may indicate the need for further medical investigation.

According to Meeusen et al. [1], overtraining syndrome is associated with an imbalance between training stress and recovery. The authors emphasize that no single physiological or biochemical marker can independently establish the diagnosis. Therefore, a comprehensive approach is required.

The purpose of this article is to examine the principal diagnostic methods used to identify cardiovascular overfatigue in athletes engaged in cyclic sports, evaluate their practical significance, and identify the advantages of an integrated monitoring approach.

LITERATURE REVIEW

The diagnosis of cardiovascular overfatigue in athletes engaged in cyclic sports has been widely discussed in sports medicine, exercise physiology, and cardiology research. Scientific studies in this field primarily focus on the physiological adaptation of the cardiovascular system to prolonged physical activity, the identification of excessive training stress, and the development of effective methods for monitoring athletes' functional conditions.

One of the important scientific contributions to this field was made by Meeusen et al. (2013), who developed a joint consensus statement on the prevention, diagnosis, and treatment of overtraining syndrome [1]. The authors emphasized that excessive training loads combined with insufficient recovery can lead to prolonged performance impairment. They also highlighted that overtraining syndrome cannot be diagnosed using a single physiological or biochemical indicator. This conclusion is particularly relevant to endurance athletes, whose cardiovascular systems are exposed to repeated and prolonged physical stress.

Sharma et al. (2017), in their International Criteria for Electrocardiographic Interpretation in Athletes, examined the differences between physiological ECG adaptations and potentially pathological abnormalities [2]. Their research established important principles for interpreting ECG findings in athletes. The authors demonstrated that certain changes, such as sinus bradycardia and early repolarization, may be normal consequences of regular athletic training. At the same time, specific abnormal patterns require further clinical investigation. These findings provide an important methodological basis for the cardiovascular assessment of athletes participating in cyclic sports.

The role of modern cardiovascular imaging in sports medicine has also received considerable attention. The European Association of Preventive Cardiology and the European Association of Cardiovascular Imaging have emphasized the importance of selecting appropriate imaging methods and interpreting their findings in accordance with the athlete's individual characteristics [3]. Echocardiography and exercise-based imaging can help distinguish physiological cardiac remodeling from pathological conditions and provide additional information when symptoms or abnormal findings are present.

**METHODS**

This article is based on a narrative review and comparative analysis of scientific publications, clinical consensus statements, and research studies concerning cardiovascular assessment, endurance training, and overtraining syndrome.

The following research methods were applied:

- **Literature analysis:** examination of scientific publications concerning cardiovascular adaptation, fatigue, and overtraining in athletes.
- **Comparative analysis:** comparison of diagnostic methods used to assess cardiovascular function in endurance athletes.
- **Systematization:** classification of clinical, instrumental, and laboratory indicators.

**Proximus Journal of Sports Science and Physical Education**
Volume 3, Issue 11, November 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

- **Generalization:** identification of the most important principles for comprehensive cardiovascular monitoring.

The analysis focused on the following diagnostic areas:

1. Clinical assessment and evaluation of training-related symptoms.
2. Resting electrocardiography and ambulatory ECG monitoring.
3. Echocardiographic assessment of cardiac structure and function.
4. Exercise stress testing and cardiopulmonary exercise testing.
5. Heart rate variability monitoring.
6. Laboratory investigations and differential diagnosis.

The article is a literature-based review and does not report original clinical measurements or experimental results. The diagnostic approaches discussed should be selected by qualified healthcare professionals according to the athlete's clinical condition.

## RESULTS

Physiological characteristics of the cardiovascular system in cyclic sports Cyclic sports place prolonged demands on the cardiovascular system. During endurance exercise, the heart increases cardiac output to meet the oxygen requirements of working muscles. This is achieved through changes in heart rate and stroke volume.

Regular endurance training can produce several physiological adaptations:

- increased stroke volume;
- improved myocardial efficiency;
- increased blood volume;
- enhanced peripheral oxygen utilization;
- reduced resting heart rate;
- improved cardiovascular response to submaximal exercise.

These adaptations are commonly associated with the concept of the "athlete's heart". However, physiological cardiac remodeling must be differentiated from pathological changes.

The distinction is particularly important in athletes who perform high-volume endurance training. Cardiac enlargement, changes in ventricular dimensions, and specific ECG patterns may occur as normal adaptations. Nevertheless, unusual symptoms or atypical findings require additional assessment.

Clinical signs of cardiovascular overfatigue Clinical assessment is the first stage in identifying possible cardiovascular overfatigue. It includes an evaluation of subjective symptoms, training history, recovery patterns, and changes in physical performance.

The following symptoms may indicate inadequate recovery or possible cardiovascular dysfunction:

- persistent fatigue despite adequate rest;
- an unexplained decline in endurance performance;
- unusual breathlessness during familiar exercise intensity;
- palpitations or irregular heartbeat;
- dizziness or near-fainting during exercise;
- prolonged recovery after training;
- unusual changes in resting or exercise heart rate;
- chest discomfort during physical activity.

These symptoms are not specific to cardiovascular overfatigue and may be associated with other medical conditions, including anaemia, infection, respiratory disorders, endocrine disturbances, or cardiovascular disease.

Proximus Journal of Sports Science and Physical Education
Volume 3, Issue 11, November 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

Special attention should be paid to chest pain, syncope during exercise, unexplained severe breathlessness, and sustained palpitations. These symptoms require prompt medical evaluation, and strenuous exercise should be suspended until an appropriate assessment has been completed.

Electrocardiography as a diagnostic method Electrocardiography is one of the most accessible methods for assessing the electrical activity of the heart. A resting 12-lead ECG can provide information about heart rhythm, conduction, cardiac electrical adaptation, and potential abnormalities.

In endurance athletes, the ECG may reveal physiological changes such as:

- sinus bradycardia;
- first-degree atrioventricular block;
- early repolarization patterns;
- increased QRS voltage;
- certain training-related changes in cardiac electrical activity.

However, some ECG findings may indicate underlying pathology and require further investigation.

The International Criteria for Electrocardiographic Interpretation in Athletes provide guidance for distinguishing common physiological adaptations from abnormal ECG patterns [2].

Ambulatory ECG monitoring, including 24-hour or longer Holter monitoring, may be useful when an athlete experiences intermittent palpitations, suspected arrhythmias, or unexplained symptoms that are not detected during a resting ECG.

Echocardiography and assessment of cardiac structure Echocardiography is a non-invasive imaging method that provides information about cardiac chambers, ventricular dimensions, myocardial thickness, valve function, and systolic and diastolic performance.

In athletes engaged in cyclic sports, echocardiography is particularly useful for distinguishing physiological cardiac remodeling from pathological structural changes.

**Table 1. Main echocardiographic parameters in cardiovascular assessment of athletes**

| Parameter | Diagnostic significance |
|---|---|
| Left ventricular dimensions | Assessment of cardiac chamber size and possible remodeling |
| Left ventricular ejection fraction | Evaluation of systolic function |
| Right ventricular dimensions and function | Assessment of right-sided cardiac adaptation |
| Left atrial volume | Evaluation of atrial remodeling |
| Myocardial wall thickness | Identification of physiological or pathological hypertrophy |
| Diastolic function | Assessment of ventricular relaxation and filling |
| Global longitudinal strain | Additional evaluation of myocardial deformation and function |

Echocardiographic results should be interpreted in relation to age, sex, body size, sport discipline, training history, and clinical findings.

Recent European consensus recommendations emphasize the importance of exercise imaging, including stress echocardiography, when resting investigations do not sufficiently explain an athlete's symptoms or abnormal findings [3].

Exercise stress testing and cardiopulmonary exercise testing Exercise stress testing is an important diagnostic method for evaluating cardiovascular responses under physical load. It allows clinicians to assess heart rate, blood pressure, exercise tolerance, symptoms, and ECG changes during progressively increasing exercise intensity.

**Proximus Journal of Sports Science and Physical Education**
Volume 3, Issue 11, November 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

For athletes in cyclic sports, treadmill and cycle ergometer tests are commonly used. The testing protocol should reflect the athlete's discipline and physical preparation.

Cardiopulmonary exercise testing (CPET) provides more detailed information by measuring oxygen uptake, carbon dioxide production, ventilation, and other physiological responses.

Important CPET parameters include:

- maximal oxygen uptake ($VO_2max$);
- oxygen uptake at the ventilatory or lactate threshold;
- heart rate response to exercise;
- oxygen pulse;
- ventilatory efficiency;
- blood pressure response;
- exercise-induced ECG abnormalities.

A reduction in exercise capacity compared with the athlete's previous individual results may indicate inadequate recovery or an emerging medical problem. However, it should not automatically be interpreted as evidence of cardiovascular overfatigue.

CPET is especially valuable when unexplained exercise intolerance is present and the underlying cause needs to be clarified.

Heart rate variability as a monitoring indicator Heart rate variability (HRV) describes variations in the time intervals between consecutive heartbeats. It is commonly used to assess aspects of autonomic nervous system regulation.

In sports practice, HRV monitoring may help identify changes in the athlete's physiological response to training and recovery.

Commonly used HRV indicators include:

- **RMSSD:** reflects short-term beat-to-beat variability and is commonly used in monitoring parasympathetic activity.
- **SDNN:** represents overall variability during the recording period.
- **Resting heart rate:** provides additional information about cardiovascular response and recovery.
- **Frequency-domain indicators:** may provide further information about autonomic regulation, although their interpretation requires caution.

A persistent deviation from an athlete's established baseline, particularly when accompanied by fatigue, poor sleep, mood changes, and reduced performance, may indicate inadequate recovery.

Nevertheless, HRV is not a standalone diagnostic test for cardiovascular overfatigue or overtraining syndrome. It should be interpreted together with clinical symptoms, training load, performance indicators, and other investigations [4, 5].

Laboratory investigations and differential diagnosis Laboratory tests may help identify medical conditions that contribute to fatigue and reduced exercise capacity.

Depending on clinical indications, investigations may include:

- complete blood count;
- ferritin and iron studies;
- electrolytes;
- renal and liver function indicators;
- thyroid-stimulating hormone;
- C-reactive protein;

**Proximus Journal of Sports Science and Physical Education**
Volume 3, Issue 11, November 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

- selected cardiac biomarkers when myocardial injury is suspected.

Cardiac troponin may increase after prolonged or strenuous exercise. Therefore, its interpretation requires attention to the timing of exercise, symptoms, serial measurements, and clinical context. It should not be used as a routine standalone marker of training fatigue.

Creatine kinase may increase after intensive muscular exercise, but it is not a specific indicator of cardiovascular overfatigue.

The diagnosis of overtraining syndrome remains complex. A scoping review by Carrard et al. [6] found that various hormonal, metabolic, psychological, cardiovascular, and performance-related indicators have been investigated, but no universally accepted diagnostic test has been established.

## DISCUSSION

The analysis demonstrates that diagnosing cardiovascular overfatigue in cyclic-sport athletes is a complex process. One of the main challenges is distinguishing normal physiological adaptations to endurance training from signs of inadequate recovery or cardiovascular pathology.

The concept of cardiovascular overfatigue should not be treated as a separate diagnosis that can be confirmed through a single heart rate, ECG, or biochemical value. Instead, it should be considered within the broader context of training-related fatigue, functional overreaching, non-functional overreaching, and overtraining syndrome.

Meeusen et al. [1] emphasize that the diagnosis of overtraining syndrome requires the exclusion of other medical conditions and the evaluation of multiple indicators. Similarly, the scoping review by Carrard et al. [6] demonstrates the absence of a universally accepted diagnostic biomarker.

The findings suggest that the most effective approach involves several complementary stages:

**First, regular clinical monitoring.** Coaches and sports physicians should record changes in performance, fatigue, sleep quality, recovery, and exercise tolerance.

**Second, individual baseline assessment.** Resting heart rate, HRV, training performance, and other physiological indicators should be compared with the athlete's own established baseline rather than interpreted using universal thresholds.

**Third, instrumental examination.** ECG and echocardiography should be used when clinically indicated. Exercise testing and CPET may provide additional information about cardiovascular function under physical load.

**Fourth, differential diagnosis.** Anaemia, iron deficiency, infection, thyroid dysfunction, myocarditis, cardiomyopathy, and other medical conditions should be considered when symptoms or abnormal findings are present.

**Fifth, individualized training adjustment.** When inadequate recovery is suspected, training volume and intensity should be reviewed, and sufficient recovery time should be provided. Medical treatment should be determined by the identified clinical condition rather than by the general concept of fatigue.

Recent European clinical consensus recommendations also highlight the importance of individualized cardiovascular imaging and exercise-based assessment in athletes, particularly when there are abnormal ECG findings or unexplained exercise-related symptoms [3, 7].

Thus, comprehensive cardiovascular monitoring can contribute to early identification of potentially dangerous conditions, more appropriate training management, and the protection of athletes' long-term health.

## CONCLUSION

The diagnosis of cardiovascular overfatigue in athletes engaged in cyclic sports is an important component of sports medicine and performance monitoring. Prolonged and repetitive physical activity

**Proximus Journal of Sports Science and Physical Education**
Volume 3, Issue 11, November 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

produces substantial cardiovascular adaptations, but excessive training stress combined with insufficient recovery may result in persistent fatigue and reduced performance.

The following conclusions can be drawn:

1. Cardiovascular assessment in endurance athletes should distinguish physiological adaptations from pathological changes.
2. Clinical examination is the initial stage of diagnosis and should include an assessment of symptoms, training history, and recovery patterns.
3. ECG and echocardiography provide important information about cardiac electrical activity, structure, and function.
4. Exercise stress testing and CPET allow cardiovascular responses and exercise capacity to be evaluated under physical load.
5. HRV can support the monitoring of autonomic regulation and recovery trends, but it should not be used as an independent diagnostic criterion.
6. Laboratory investigations are important for identifying conditions such as anaemia, iron deficiency, electrolyte disturbances, and other possible causes of fatigue.
7. The most reliable diagnostic approach is comprehensive, individualized, and based on the combination of clinical, instrumental, and laboratory findings.

In conclusion, early identification of abnormal cardiovascular responses, appropriate interpretation of diagnostic indicators, and cooperation between sports physicians, cardiologists, coaches, and athletes are essential for maintaining cardiovascular health and optimizing training effectiveness in cyclic sports.

**REFERENCES**

1. Meeusen, R., Duclos, M., Foster, C., et al. (2013). Prevention, Diagnosis, and Treatment of the Overtraining Syndrome: Joint Consensus Statement of the European College of Sport Science and the American College of Sports Medicine. *Medicine & Science in Sports & Exercise*, 45(1), 186–205. https://doi.org/10.1249/MSS.0b013e318279a10a
2. Sharma, S., Drezner, J. A., Baggish, A., et al. (2017). International Criteria for Electrocardiographic Interpretation in Athletes: Consensus Statement. *British Journal of Sports Medicine*, 51(9), 704–731. https://bjsm.bmj.com/content/51/9/704
3. European Association of Preventive Cardiology and European Association of Cardiovascular Imaging. (2026). Indications, Protocols, and Interpretation of Cardiovascular Imaging for the Evaluation and Management of Athletes: Part 1—Exercise Imaging. *European Heart Journal - Cardiovascular Imaging*. https://doi.org/10.1093/ehjci/jeag130
4. Plews, D. J., Laursen, P. B., Stanley, J., Kilding, A. E., & Buchheit, M. (2013). Training Adaptation and Heart Rate Variability in Elite Endurance Athletes: Opening the Door to Effective Monitoring. *Sports Medicine*, 43, 773–781. https://doi.org/10.1007/s40279-013-0071-8
5. Bellenger, C. R., Fuller, J. T., Thomson, R. L., Davison, K., Robertson, E. Y., & Buckley, J. D. (2016). Monitoring Athletic Training Status Through Autonomic Heart Rate Regulation: A Systematic Review and Meta-Analysis. *Sports Medicine*, 46, 1461–1486. https://doi.org/10.1007/s40279-016-0484-2
6. Carrard, J., Rigort, A. C., Borrani, F., Millet, G. P., & Rössler, R. (2022). Diagnosing Overtraining Syndrome: A Scoping Review. *Sports Health*, 14(5), 665–673. https://doi.org/10.1177/19417381211044739

**Proximus Journal of Sports Science and Physical Education**
Volume 3, Issue 11, November 2026
https://proximusjournal.com/index.php/PJSSPE
ISSN (E): 2942-9943

7. European Association of Preventive Cardiology. (2025/2026). Abnormal Electrocardiogram Findings in Athletes: A Consensus Statement of the European Association of Preventive Cardiology of the European Society of Cardiology. *European Heart Journal*, 47(2), 152–169. https://doi.org/10.1093/eurheartj/ehaf646
8. Pelliccia, A., Sharma, S., Gati, S., et al. (2021). 2020 ESC Guidelines on Sports Cardiology and Exercise in Patients with Cardiovascular Disease. *European Heart Journal*, 42(1), 17–96. https://doi.org/10.1093/eurheartj/ehaa605
9. American College of Sports Medicine. (2021). *ACSM's Guidelines for Exercise Testing and Prescription* (11th ed.). Wolters Kluwer. https://www.acsm.org/education-resources/books/guidelines-exercise-testing-prescription
10. Kreher, J. B., & Schwartz, J. B. (2012). Overtraining Syndrome: A Practical Guide. *Sports Health*, 4(2), 128–138. https://doi.org/10.1177/1941738111434406