

Assessment of the dynamics of the physical and functional state of athletes of the highest category in the conditions of the COVID-19 pandemic based on the use of digital technologies

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Abstract. The aim of the study was to monitor the reaction of athletes to COVID-19 and to develop a methodology for monitoring the physical and functional condition of highly qualified basketball team players in the conditions of the COVID-19 pandemic. The relevance of the study lies in the fact that in professional sports today, a methodology for assessing the physical and functional state of athletes in the context of the COVID-19 pandemic is only being formed. Of particular interest is the application of digital technology, since it gives accurate and objective results. The technique developed in the course of the study can be used not only to analyze the condition of highly qualified basketball players, but also for athletes of other team sports - volleyball, handball, football and others.

1 Introduction

Due to the COVID-19 pandemic many international sports competitions have been canceled or postponed. After a long break, the training and competitive process for highly qualified athletes was resumed in the presence of special restrictions and constant monitoring of the condition of athletes using modern digital technologies. In addition, immediately before the competition, athletes systematically take a test to detect coronavirus infection. Despite the measures taken, the incidence of athletes remains at a high level, which negatively affects the performance results. This is primarily because recovery after COVID-19 is a rather lengthy and complex process that requires an individual approach.

Since COVID-19 is a relatively new virus, there is not much information about it in the scientific literature today. Only data collection, their primary processing and analysis are carried out. The theses on the effect of COVID-19 on the athletes' body and the peculiarities of athletes' recovery after the disease have not yet been formed. To date, it is known that COVID-19 is a potentially severe acute respiratory infection caused by the SARS-CoV-2 coronavirus [1]. This virus for humans can occur in the form of acute respiratory viral infection with a mild course, or in severe form, specific complications of which may include

viral pneumonia, entailing acute respiratory distress syndrome or respiratory failure with a high risk of death [1, 2].

Experts are currently studying factors that contribute to strengthening the protective functions of the immune system of the human body in countering COVID-19. It has been proven that systematic physical activity contributes to the improvement of mitochondrial biogenesis, mitochondrial respiration, mitochondrial protein synthesis, higher dependence of mitochondria on fatty acid substrates and better management of oxidative stress [3, 4]. However, the sport of the highest achievements implies hyper loads and athletes are often in a state of overtraining [5, 6, 7]. In particular, the calendar of the professional basketball league is quite dense. Basketball players spend 1-2 games during the week. In the presence of field trips, continuous training and competitive process, there is not enough time for a full recovery. This mode leads to mitochondrial dysfunction and weakening of the immune defense. In addition, scientific studies confirm that athletes who place high demands on their cardiorespiratory system, when a positive result for COVID-19 appears, residual symptoms (cough, tachycardia and severe fatigue) are observed for a long time after infection, even with a mild course of the disease [1].

In the 2020-2021 season, 20% of the games in the Basketball Championship Premier League were postponed due to high morbidity among players. All the above factors indicate that athletes are at risk and are particularly susceptible to COVID-19 disease.

2 Materials and Methods

The purpose of the study was to develop a methodology for monitoring the physical and functional condition of athletes in the conditions of the COVID - 19 pandemic based on the use of digital technologies. One of the objectives of the study was to study the features of the course of COVID – 19 diseases in athletes and recovery after the virus. Particular attention was paid to the comparison of functional indicators and indicators of load tolerance before and after the disease [8, 9].

The study involved 10 players of the Rostov-Don-SFU basketball team, including 3 masters of sports and 8 CMS (average age - 22.9 ± 2.8 years, average experience - 12 ± 1.4 years). The analysis of the functional state of basketball players with subsequent processing and evaluation of data was carried out from September 2020 to January 2021 based on Polar h10 heart rate monitors, polar vantage V watches and the Polar flow program. This Polar system allows you to obtain reliable data on heart rate variability, load tolerance and the course of recovery of the cardiovascular system. Further, the data obtained were subjected to statistical processing. The obtained materials were compared with similar indicators taken in the 2021-2022 season.

3 Results

Rostov-Don-SFU players have been systematically tested for coronavirus infection over the past two playing seasons. A negative test for COVID-19 is a prerequisite for admission to the game. In case of a positive result, the player is immediately sent to quarantine and ceases his participation in the training process. During the 2020-2021 season, 7 players and 10 at different times received a positive result of a PCR test for the presence of COVID-19. seasons. A negative test for COVID-19 is a prerequisite for admission to the game. In case of a positive result, the player is immediately sent to quarantine and ceases his participation in the training process. During the 2020-2021 season, 7 players and 10 at different times received a positive result of a PCR test for the presence of COVID-19.

According to the results of an immunoserological study of blood serum, which all team players completed by February 2021, SARS-CoV- 2 IgG antibodies were found in all team members. That is, all the players suffered a coronavirus infection, the difference was only in the presence or absence of symptoms.

From June to August, all players, together with the coaching staff, underwent a full course of Sputnik V vaccination. The vaccine is based on an adenovirus vector with a fragment of SARS-CoV-2 genetic material embedded in it, which contains information about the structure of the S-protein of the virus spike. Despite the presence of antibodies in three players, the coronavirus was re-detected in the 2021-2022 season.

In the 2020-2021 season, the course of the disease was accompanied by symptoms such as weakness, partial loss of sense of smell and low temperature. In the 2021-2022 season, sore throat and cough were added to the symptoms. Also, the players who were ill noted that for a long time there were temperature jumps in the evening.

In order to monitor the condition of the basketball players and adequately assess their reaction to the training and competition process, the coaching staff introduced the daily use of Polar h10 heart rate monitors, polar vantage V watches and Polar flow programs.

In the 2020-2021 season, all players who showed symptoms of coronavirus were in the overtraining phase shortly before the disease, according to data obtained using the Polar monitoring system. The athletes' bodies did not have time to recover between training and games. This led to a weakening of the immune defense against the background of mitochondrial dysfunction [10, 3, 11].

In the 2021-2022 season, 3 players who were ill in the previous season and were vaccinated again received a positive test result for COVID-19. Figures 1 and 2 show graphs of cardio loads of basketball players who have fallen ill with COVID-19. In all cases, the players fell ill immediately after they reached the overtraining phase (Fig.1 - positive test for COVID-19 from 11.01.22).

Table 1. Results of PCR diagnostics for the presence of Coronavirus (SARS-CoV-2) in the season 2020-2021 and season 2021-2022

Rostov-Don-SFU players	Positive test for COVID-19 in the 2020-2021 season	Analysis date	IgM	IgG	June August. Vaccination SPUTNIK - V	Positive test for COVID-19 in the 2021-2022 season
K. K.	14.10.2020	05.11.20	1.82	26.47	+	no
P. V.	18.11.2020	05.01.21	1.57	15.21	+	no
G. L.	21.10.2020	05.11.20	1.34	5.46	+	no
Sh.A.	16.11.2020	05.01.21	0.87	13.42	+	25.01.22
V. E.	17.11.2020	05.01.21	0.92	14.52	+	11.01.22
G. E.	28.10.2020	05.11.20	0.95	1.33	+	no
G. Y.	08.10.2020	05.11.20	0.48	23.96	+	19.01.22
Z. A.	no	05.11.20	0.60	12.78	+	no
P. D.	no	05.11.20	0.93	12.51	+	no
M. A.	no	05.02.21	0.58	12.63	+	no

It should be noted that during the three months before the disease, the basketball players adequately perceived the load of the training process and fully recovered. The Polar system also evaluates the level of tension and endurance [12, 5]. So, in Figure 1, the peak of tension falls on the tenth of January, after which the endurance of the player demonstrates the dynamics of decline.

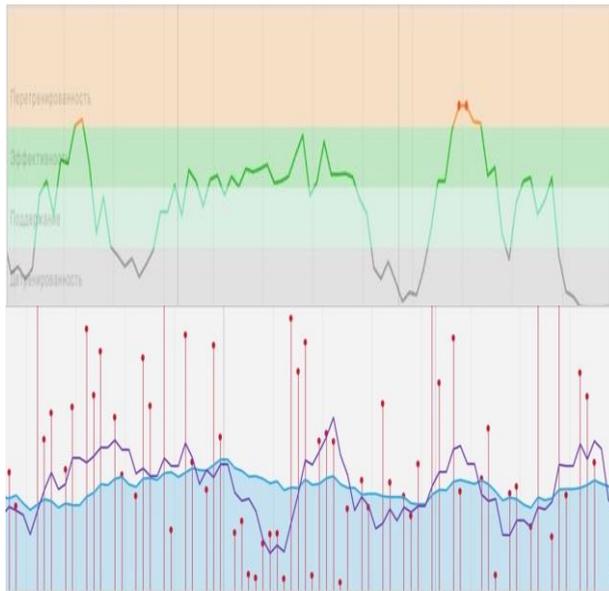


Fig. 1. Graph of cardio load, stress level and endurance of a player with COVID-19 (3 months).

Figure 2 shows similar data of the second basketball player who was ill (Figure 2 - positive test for COVID-19 from 25.01.22). The graph shows the monthly dynamics of cardio loads. The player also entered the zone of overtraining and maximum tension in the second half of January, which led to a weakening of the immune defense and, as a result, to the disease. All three of the basketball players who fell ill fell ill at about the same time.

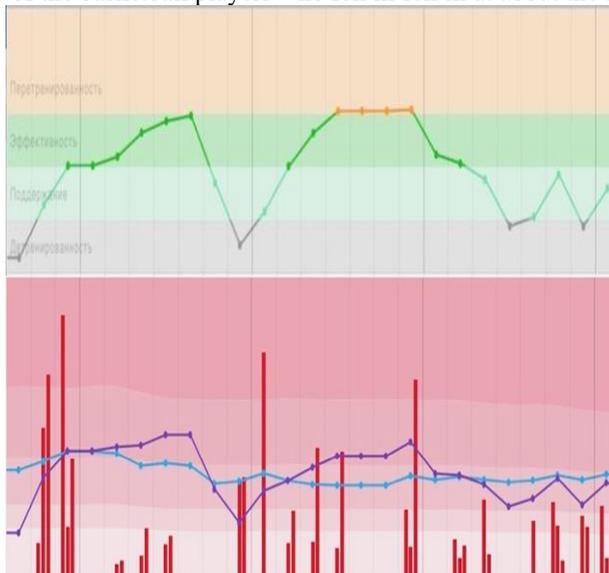


Fig. 2. Graph of cardio loads, stress level and endurance of a player with COVID-19.

It should be noted that those players who suffered the virus in the 2020-2021 season without symptoms were not included in the group of cases again. In addition, the Polar software package recorded that the other players who did not get sick with COVID-19 perceived a similar load in an effective mode with cardio load indicators not exceeding the norm [13, 14, 15].

The coaching staff has developed the following algorithm for monitoring the functional state of players and behavior in case of COVID-19.

1. Every day, players take an orthostatic test.
2. A diary of the condition is kept based on a subjective assessment.
3. Monitoring of the functional state based on digital technologies and analysis of big data obtained based on Polar h10 heart rate monitors, polar vantage V watches and the Polar flow program.
4. Control of heart rate variability and reduction of loads in case of overtraining phase.
5. Testing for COVID-19 before official matches
6. In case of a positive test, the player is sent to a week-long quarantine.
7. Admission to training is carried out with the permission of the team doctor after receiving a negative test and an individual assessment of the condition.

Table 2. Results of temperature measurement during the first seven days of COVID-19 disease

Body temperature indicator of the disease COVID-19, °C						
1 day	2 day	3 day	4 day	5 day	6 day	7 day
37.0	36.9	37.0	37.0	37.2	36.9	37.0
37.6	37.4	37.5	37.3	37.2	37.3	37.2
37.5	37.5	37.1	37.1	37.0	36.6	36.8
37.4±0.3	37.3±0.3	37.2±0.3	37.1±0.1	37.1±0.1	36.9±0.4	37.0±0.2

Special attention should be paid to the indicators of measuring the body temperature of athletes during repeated illness and during the recovery period after COVID-19. Upon receiving a positive test for COVID-19, the team players began to keep a diary of self-observations, in which the following indicators were noted: body temperature, assessment of general condition, manifestation or absence of symptoms - cough, headache, sore throat, loss of taste and smell. As can be seen from the table 2, during the week the players who fell ill with COVID-19 had a low temperature (37.1 ± 0.2). However, according to the observations of the basketball players, it should be noted that after receiving a negative test for COVID-19 and gradually returning to the training process, the temperature rose again during the week.

Table 3. Assessment of the manifestation of the main symptoms during COVID-19 disease in the seasons 2020-2021 and 2021-2022

Sore throat	Headache	Dry cough	Loss of taste and smell	Runny nose
season 2020-2021				
+	+	+	+	-
+	+	+	+	+
+	+	+	+	+
season 2021-2022				
-	+	-	+	-
+	+	-	+	-
-	+	-	+	+

With the primary COVID-19 disease, the players, in addition to temperature, noted symptoms of the disease such as headache, loss of taste and smell, dry cough, runny nose, sore throat (table 3). With repeated illness, only headache and loss of taste and smell remained from the symptoms. In general, the study participants confirmed that in the 2021-2022 season they suffered COVID-19 more easily and were able to recover their physical condition faster.

4 Discussion

The Rostov-Don-SFU basketball team is competing in the Russian Premier League championship in the 2021-2022 season. Before entering the Premier League, the team took part in Super League 1, where it was the leader of the championship. The coaching staff actively uses advanced digital technologies in the construction of the training process and for the analysis of gaming activities.

Since the onset of the pandemic, the coaching staff has developed a methodology for monitoring the condition of players in the conditions of the COVID-19 pandemic and the resumption of sports activities for athletes who have suffered from the disease [16, 9]. Based on observations for the 2020-2021 season, it was revealed that highly qualified athletes in the conditions of a pandemic are in a special risk group and are susceptible to disease. Extreme physical exertion and overloading lead to mitochondrial dysfunction and weakening of immune protection. In such conditions, it is advisable to monitor the condition of athletes, including with the help of digital technologies, and to prevent the overtraining phase [10, 11, 17]. Even though 70% of the team's players had the virus, all the basketball players were able to return to the training and competitive process.

At the second stage of the study, it was revealed that even under the condition of vaccination and the COVID-19 disease, when entering the overload phase, the athlete still falls into the risk group and may get sick again. 3 out of 10 players again received positive tests for COVID-19 in January 2022.

Repeated COVID-19 disease took place in Rostov-Don-SFU players in a mild form. Among the main symptoms of the basketball player, in addition to fever, headache and loss of smells and tastes were noted. The fact that the disease was repeated in a milder form may be the result of the beneficial effect of vaccination and adaptation of the body after the primary disease. Nevertheless, recovery after COVID-19, even after repeated illness, is quite long and should be carried out on the basis of an individual approach. The return of the basketball players who had been ill to the training process with the main group was accompanied by an increase in temperature. This fact confirms the hypothesis about the need for in-depth monitoring of the body of highly qualified athletes at the stage of recovery after repeated COVID-19 disease.

The results obtained during the study indicate that the repeated COVID-19 disease passes in a mild form, nevertheless, negatively affects the functional and physical condition of the players, reduces endurance.

The measures taken by the basketball league aimed at combating the spread of coronavirus among athletes are insufficient and should be accompanied by in-depth monitoring of the condition of athletes conducted within each team [18, 19]. In the presence of digital equipment, this process can give high efficiency results and prevent the weakening of the athlete's immune defense.

5 Conclusion

The results of the study indicate that despite vaccination and COVID-19 disease, highly qualified athletes are at risk of re-infection [20]. In order to protect the players and prevent the risk of COVID-19 spreading among the team, it is advisable to conduct in-depth monitoring of the functional state using digital technologies [6, 7]. This monitoring should be aimed at reducing the training regime individually in order to prevent the weakening of the immune defense in case the player reaches the phase of extreme physical exertion and overloading.

If there is a positive test for COVID-19, it is extremely important to isolate the player from the team and provide the necessary conditions for a speedy recovery. The return to the

training process should be carried out under the supervision of a team doctor on the basis of an individual approach.

The proposed method of using digital technologies to monitor the functional state of athletes will allow organizing an effective and painless recovery after COVID-19, since it will allow monitoring the body's response to loads. Even though basketball is a team sport, in the conditions of a pandemic, an individual approach should be taken to the players in terms of their tolerance of physical activity and the rehabilitation process after the COVID-19 disease. The technique developed in the course of the study can be used not only to analyze the condition of highly qualified basketball players, but also for athletes of other team sports - volleyball, handball, football and others.

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