MILD CASES OF COVID-19 DO NOT AFFECT THE CARDIO-RESPIRATORY FITNESS OF ELITE BULGARIAN FOOTBALL PLAYERS

Zdravko Taralov[1], Petar Dimov[1], Ivan Gruev[2,3], Blagoi Marinov[1], Stefan Kostianev[1]

[1] Medical University of Plovdiv, Pathophysiology Department

[2] Eurovita Sports Clinic, Sofia

[3] National Multi-profile Transport Hospital Tsar Boris III, Sofia

Introduction

From the beginning of the COVID-19 pandemic, more than 215 million people in the world were affected with more than 4,5 million deaths, attributed to this disease [1]. Clinical manifestation and complications are much more common among the elderly, however many young people as well as athletes were also affected by the disease. Evidence was found that COVID-19 could be transmitted by asymptomatic or pre-symptomatic individuals which led to the cancellation of many sports events and championships as well as the Bulgarian Football League, which had a huge individual, financial and social impact [2]. On the basis of the limited available data, athletes who tend to be younger with no comorbidities are less likely to develop moderate to critical symptoms from COVID-19 and may instead be asymptomatic or experience a mild, flu-like illness [3]. Since young athletes are people with a very good health status and strong immune response, the majority of cases were characterized by absent or very mild clinical sings such as fatigue, muscle pain, subfebrile core body temperature, loss of smell or taste and did not develop the complete clinical manifestation associated with pneumonia, dyspnea and acute respiratory distress syndrome. However, with time it was understood that COVID-19 is not only associated with acute complications but it can also cause an autoimmune response causing different chronic complications such as thrombosis, myocarditis, autonomic dysfunction [4], left or even right ventricular dysfunction, that were also observed in some athletes [5], arrhythmias and acute-onset heart failure [6], neuropsychiatric sequel [7]. Many athletes complained of inexplicable fatigue on the background of completely normal cardio-pulmonary and blood tests, which could be speculated to be a result of the post COVID-19 autonomic dysfunction [8], whoever some other authors suggested that the fatigue is not a result of the autonomic dysfunction [9]. These complications could be present up to 6 months after COVID-19 and they not only affect the performance of the players but could hide the risk of fatal events during exercise such as sudden cardiac death (SCD) [10].

After it was proven that football, despite being a high contact sports, hides a very low risk for COVID-19 transmission, the elite football leagues were restarted [2]. However, to protect the health of the players, individual protocols for return to sport were implemented in different countries, that include epidemiological, diagnostic and training recommendations [11]. It was agreed that the return to intensive sports activity should happen only after undergoing a panel of cardio-vascular test, part of which should be the cardio-pulmonary exercise testing [5,6]. Its indications are not only diagnostical, finding some latent cardio-pulmonary disorders, but it can also assess the functional and physical capacity of the elite athletes after the lock-down situation where the possibilities for training were limited [12].

COVID-19 affected a large number of Bulgarian professional football players as well. All of them were able to soon return to competitive games. There is scarce information

regarding the long-term potential effects of this infection for the professional athletes. Mehrsafar et al. point out a variety of reported post-COVID-19 complications, including sleep disorders, eating disorders, anxiety, depression, etc. which could be attributed not only to the disease itself, but to the stressful situation in which it puts professional athletes – with social isolation, inability to train effectively and all the other necessary lifestyle changes [13].

Aim

We aimed to evaluate the functional physical capacity by a cardio-pulmonary exercise test among elite Bulgarian football players before being medically diagnosed with COVID-19 infection and after recovery has taken place.

Subjects and Methods

To reach our goal, professional football players were selected, strictly following the inclusion and exclusion criteria of the study. The inclusion criteria were as follows: a football player, part of an elite club from the First Bulgarian league, who had been tested positive with PCR test for COVID-19 during the screening of the team, or due to having symptoms of the disease. All subjects had to have suffered mild or moderate form of COVID-19 infection without acute complications and to have resumed their training and participation in competitive games. The player had to have undergone a primary cardio-pulmonary exercise testing not more than 6 months prior to contracting the infection. Exclusion criteria were as follows: severe forms of COVID-19; patients who had been referred to the intensive care unit or intubated; severe cardio-vascular or respiratory complications; patients whose primary CPET took place more than 6 months prior to the disease contraction or performed on a different ergometer or protocol of testing, which would make the results incomparable.

A total of 24 players of two clubs from the First Bulgarian Football league were tested positive with PCR, which makes more that 50% of the players tested. The majority of the players (11 players/ 46% of the positive) had an asymptomatic form of COVID-19. All the players were tested negative 14 days after the initial positive test. Six of the players experienced mild flu-like symptoms like subfebrile body temperature, sore throat, mild, non-productive cough, fatigue and headache. Pain in the muscles, joints and bones were the main symptoms in 2 of the players and intensive headache was the only symptom in another 2 of the cases. Eight of the players lost their olfactory sense and/or taste. Only three players experienced a more complete clinical manifestation of the disease with more severe symptoms like dyspnea, persistent cough, fever and medication therapy was applied in those patients. None of the players was referred to a hospital, intubated or needed oxygen treatment. All of the players were quarantined at home and all of them were tested negative 14 days after the first test. The asymptomatic players and those with mild clinical symptoms were provided with cycling ergometers at home and were able to keep basic level of physical activity. Only 8 players covered the inclusion and exclusion criteria and were included in comparison analysis. The test of the players began with spirometry to evaluate their pulmonary ventilation. Then CPET was performed to each of the players. Six of the players were tested on a treadmill ergometer (Trackmaster, USA), using a standardized protocol, approved for athletes testing in Bulgaria with a constant slope of 2% and 1.5 minutes steps, increasing the speed by 1.2 km/h per step. Two of the players with

medical indications were tested on a bicycle ergometer (Ergoselect 100, Ergoline, Bitz, Germany) using 20W/min incremental ramping protocol. Each test was ended when maximal effort of the athlete was reached followed by 4 minutes recovery period with simultaneous recording of 12-channel ECG. The gas collection and metabolic analysis of the test was performed by CPET system Ultima PFX, Mortara, Saint Paul, MN, USA. The spirometry and CPET were performed strictly following the anti-COVID-19 epidemiological recommendations [12].

The statistical analysis was performed using Independent-sample T-test (SPSS v.17.0). Normality of distribution was checked by Shapiro-Wilk test. Since the group of the tested players was not big enough, the individual changes in the CPET parameters before and after COVID-19 were also expressed and analyzed.

All studies carried out on humans in the Department of Pathophysiology in the Medical University of Plovdiv are in compliance with the Helsinki Declaration.

Results and discussion

We found no statistically significant difference in the performance of the athletes before and after being ill with COVID-19 in terms of overall test duration (15.55±2.10 vs 16.0±1.50 min, p=0.562) (**Fig. 1**), maximal oxygen consumption $VO_{2max/kg}$ (46.87±5.92 vs 48.32±6.43 ml/kg/min, p=0.515), ventilatory treshold (VT1) as a percentage of the total duration (79.63±4.80 vs 78.38±5.85, p=0.719) and maximal heart rate (178.88±7.83 vs 176.0±8.94 bpm, p=0.297). No change was found in the spirometric parameters, like forced vital capacity (% of predicted) (FVC%) (101.14±4.49 vs 100.63±8.16, p=0.884) and forced expiratory volume for 1 second (% of predicted) (FEV1%) (98.57±15.49 vs 98.0±15.62) (**Table 1**).

Given the small sample size, we resorted to examining individual dynamics and there were some worth mentioning, regardless of the overall seemingly similar results before and after the disease. One of the subjects who had a richer clinical presentation of the disease had a decrease in the total duration of 30 seconds – from 18 min to 17 min and 30 seconds. That may seem not a big difference in general, but in professional sport is a substantial decrease of form. In the baseline test the VT1 in that subject appeared at 80% of the total duration of the test, while in the post-covid test the VT1 appeared at 75% of the duration. Considering the shorter duration of the second test, it turns out that after having recovered from COVID-19 this athlete reached his VT1 77 seconds earlier as compared to the baseline test. The maximal heart rate as well as the heart rate during recovery were almost identical between the two tests which suggests that he spent similar effort but produced a lower result the second time. Another of the players with milder symptoms had a drastic change in the recovery heart rate. Although maximal HR at the peak of exertion was similar in both tests, the HR at the 2nd minute of recovery was 141 vs 156 bpm in the baseline and post-COVID-19 tests, respectively. Total duration was exactly the same in the two tests, however during the second one, the player showed significantly poorer ability to recover (**Fig. 2**). Such changes might be the result of deconditioning and the overall fatigue that many patients report after COVID-19. They might as well be a result of a chronotropic incompetence which has been reported in such cases as well [14]. Although the dynamics may seem tiny at first, we have to keep in mind that those people are subjected to regular everyday physical trainings and weekly competitive games and even if their performance would not be altered in one or two matches, throughout the season, in the long run, it may

become more and more difficult for them to keep up with their previous performance and results. That makes it recommendable that re-tests are being performed as well as other tests which aim to assess the functional state of the autonomic nervous system, for example, testing the heart rate variability (HRV) as commonly used method for autonomic nervous system assessment in athletes [15].

Perhaps the biggest limitation of our study is the small sample size, which is a result of the strict inclusion and exclusion criteria that we implemented. Sometimes, due to medical or non-medical reasons, football players are tested on a cycle ergometer instead of a treadmill. Although there are parameters that could be compared between a test on both devices with one and the same athlete, we believe that is not accurate and holds the potential of leading to false assumptions. We also insisted on limiting the timeframe as much as possible in order to limit the possible impact of other factors, including ageing, presence of injuries, etc. The pathophysiology of COVID-19 and its exact mechanisms of tissue and cellular damage in the lungs as well as in other organs is still holding some secrets which makes it more difficult to interpret clinical data, not to mention, giving prognosis for the long-term future. With the current situation and the number of cases on the rise again, we could expect that there would be other athletes recovered from that disease in the future and their results could be pooled with those to achieve a higher statistical significance. Probably some of the athletes would get reinfected as such cases have already been described, so this would just enrich the variety of clinical presentations that sports medics should deal with.

Conclusion

Mild cases of COVID-19 do not affect the functional capacity of elite Bulgarian football players, assessed by CPET. Despite that, special attention has to be paid to individual specifics and differences in the disease course. Although scarce in terms of data, our study suggests that even the asymptomatic cases of this new disease among athletes should better be closely monitored and measures should be taken to avoid late complications [16] after returning to full-scale professional training and competitive games. This is especially valid for patients with some pre-existing cardiological findings, since myocarditis and the potential risk of sudden cardiac death are among the commonly reported possible perils in patients, recovered from COVID-19.

Keywords: COVID-19, football, cardio-pulmonary exercise test

Acknowledgements: The authors have no conflicts of interest to disclose.

References:

1. https://www.worldometers.info/coronavirus/
2. Schumacher YO, Tabben M, Hassoun K, Al Marwani A, Al Hussein I, Coyle P, Abbassi AK, Ballan HT, Al-Kuwari A, Chamari K, Bahr R. Resuming professional football (soccer) during the COVID-19 pandemic in a country with high infection rates: a prospective cohort study. Br J Sports Med. 2021;bjsports-2020-103724.
3. Mulcahey MK, Gianakos AL, Mercurio A, Rodeo S, Sutton KM. Sports Medicine Considerations During the COVID-19 Pandemic. Am J Sports Med. 2021;49(2):512-521

4. Barizien N, Le Guen M, Russel S, Touche P, Huang F, Vallée A. Clinical characterization of dysautonomia in long COVID-19 patients. Sci Rep. 2021;11(1):14042.
5. Phelan D, Kim JH, Elliott MD, Wasfy MM, Cremer P, Johri AM, Emery MS, Sengupta PP, Sharma S, Martinez MW, La Gerche A. Screening of Potential Cardiac Involvement in Competitive Athletes Recovering From COVID-19: An Expert Consensus Statement. JACC Cardiovasc Imaging. 2020;13(12):2635-2652.
6. Dores H, Cardim N. Return to play after COVID-19: a sport cardiologist's view. Br J Sports Med. 2020;54(19):1132-1133.
7. Dasgupta A, Kalhan A, Kalra S. Long term complications and rehabilitation of COVID-19 patients. J Pak Med Assoc. 2020;70(Suppl 3)(5):S131-S135.
8. Shouman K, Vanichkachorn G, Cheshire WP, Suarez MD, Shelly S, Lamotte GJ, Sandroni P, Benarroch EE, Berini SE, Cutsforth-Gregory JK, Coon EA, Mauermann ML, Low PA, Singer W. Autonomic dysfunction following COVID-19 infection: an early experience. Clin Auton Res. 2021;31(3):385-394.
9. Townsend L, Moloney D, Finucane C, McCarthy K, Bergin C, Bannan C, Kenny RA. Fatigue following COVID-19 infection is not associated with autonomic dysfunction. PLoS One. 2021;16(2):e0247280.
10. Perillo Filho M, Francisco RC, Garcia TG, Teixeira MF, Bassaneze B, Albuquerque LCA, Alô ROB, Colombo C, Ghorayeb N. Sports in Covid-19 Times: Heart Alert. Arq Bras Cardiol. 2020;115(3):303-307.
11. Mohr M, Nassis PG, Brito J, Randers MB, Castagna C, Parnell D, Krustrup P. Return to elite football after the COVID-19 lockdown. Managing Sport and Leisure. 2020; 2375-0480
12. Faghy MA, Sylvester KP, Cooper BG, Hull JH. Cardiopulmonary exercise testing in the COVID-19 endemic phase. Br J Anaesth. 2020;125(4):447-449.
13. Mehrsafar AH, Gazerani P, Moghadam Zadeh A, Jaenes Sánchez JC. Addressing potential impact of COVID-19 pandemic on physical and mental health of elite athletes. Brain Behav Immun. 2020;87:147-148.
14. Zhou M, Wong CK, Un KC, Lau YM, Lee JC, Tam FC, Lau YM, Lai WH, Tam AR, Lam YY, Pang P, Tong T, Tang M, Tse HF, Ho D, Ng MY, Chan EW, Wong ICK, Lau CP, Hung IF, Siu CW. Cardiovascular sequalae in uncomplicated COVID-19 survivors. PLoS One. 2021;16(2):e0246732.
15. Aubert AE, Seps B, Beckers F. Heart rate variability in athletes. Sports Med. 2003;33(12):889-919.
16. Schellhorn P, Klingel K, Burgstahler C. Return to sports after COVID-19 infection. Eur Heart J. 2020 Dec 7;41(46):4382-4384.

Table 1. Comparison of the results from the pulmonary function testing and the CPET between the two visits – before and after COVID-19

Parameter	Pre COVID-19	Post COVID-19	p
Time (min)	15.55±2.10	16.0±1.50	0.562
VO_{2max} (ml/kg/min)	46.87±5.92	48.32±6.43	0.515
VT1 (%)	79.63±4.80	78.38±5.85	0.719
HR_{max} (bpm)	178.88±7.83	176.0±8.94	0.297
FVC (%predicted)	101.14±4.49	100.63±8.16	0.884
FEV_1 (%predicted)	98.54±15.49	98.0±15.62	0.945
FVC (L)	5.80±0.55	5.66±0.61	0.665
FEV_1 (L)	4.63±0.78	4.57±0.79	0.875

Legend: VO2max – maximal oxygen consumption, VT1 – first ventilatory treshold, HR – heart rate, FVC – forced vital capacity, FEV1 – forced expiratory volume in the first second

Fig. 1 Individual comparison between the total duration of the test in the two visits (1 and 2)

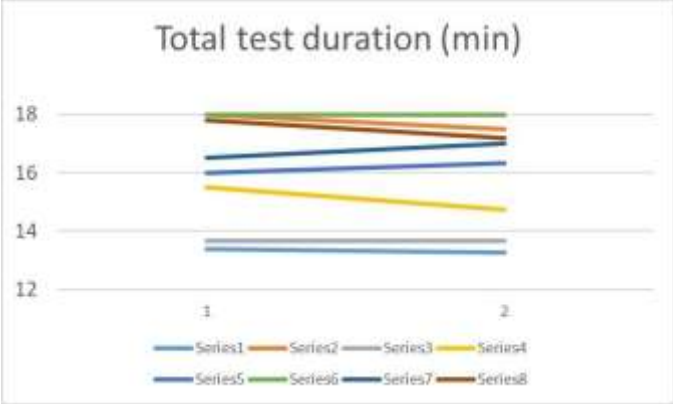

Fig. 2 Individual comparison of the recovery of the heart rate in the two consecutive visits (1 and 2)