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Impact and control of the COVID pandemic in an elite sports club: Real Madrid

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ABSTRACT

The incidence and risk factors for poor outcome in patients with COVID are well known, as are the protective measures in high-risk populations. In contrast, the epidemiological and clinical behavior of this disease in the population of elite athletes who are the paradigm of good health is poorly understood. Data on COVID in athletes are scarce and have focused preferentially on the consequences on sports performance of confinement measures and on the pathophysiological risks of infected athletes.

Real Madrid is a large elite sports institution with facilities in the City of Madrid where 600 athletes train daily. The incidence of COVID during a study period of 671 days of observation in athletes, professional or amateur, working in the institution has been 0,74 per 1,000 days of exposure. The disease has been asymptomatic or oligosymptomatic in all athletes and did not require any hospital admissions.

The different teams did not have to suspend any of its sportive commitments for COVID during the study period and there was no evidence of outbreaks of internal transmission between members of the different teams.

Keywords: COVID-19, SARS-CoV-2, prevention, sport medicine, Real Madrid, elite athletes

Impacto y control de la pandemia de COVID en atletas de un club deportivo de élite: Real Madrid

RESUMEN

La incidencia y los factores de riesgo de mal pronóstico en pacientes con COVID son bien conocidos, así como las medi-

das de protección en poblaciones de alto riesgo. En cambio, el comportamiento epidemiológico y clínico de esta enfermedad en la población de deportistas de élite que son el paradigma de la buena salud, es poco conocido. Los datos sobre COVID en deportistas son escasos y se han centrado preferentemente en las consecuencias sobre el rendimiento deportivo de las medidas de confinamiento y en las consecuencias fisiopatológicas de los deportistas infectados.

El Real Madrid es una gran institución deportiva de élite con instalaciones en la ciudad de Madrid donde entrenan diariamente 600 atletas. La incidencia de COVID durante un periodo de estudio de 671 días de observación en deportistas profesionales o amateurs que trabajan en la institución ha sido de 0,74 por cada 1.000 días de exposición. La enfermedad ha sido asintomática u oligosintomática en todos los atletas y no ha requerido ningún ingreso hospitalario.

Los equipos no tuvieron que suspender ninguno de sus compromisos deportivos por COVID durante el periodo de estudio y no hubo evidencia de brotes de transmisión interna entre miembros de los diferentes equipos.

Palabras clave: COVID-19, SARS-CoV-2, prevención, medicina deportiva, Real Madrid, deportistas de élite

INTRODUCTION

The COVID pandemic is a unique experience in which an enormous amount of scientific data has been collected on the virological aspects of SARS-CoV-2, diagnostic difficulties, therapeutic aspects and those related to prevention [1-6].

Data on the behavior and characteristics of the disease in particular population segments have focused preferentially on those most predisposed to have a poor disease course, particularly the elderly and immunocompromised disease groups [7-13].

Relatively few publications, however, focus instead on the impact of COVID-19 in groups of people who are the paradigm

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of good health and particularly in groups of elite athletes who are often subjected to extraordinary disease prevention measures [14–21]. Those publications generally refer to the impact of the disease specifically on the performance of specific athletes and do not include the impact of COVID on a large sports institution as a whole [22].

Real Madrid is a club of elite athletes in whose facilities 600 athletes of soccer and basketball disciplines train and attend daily.

We report the anti-COVID control measures adopted in the Real Madrid training Centre (Ciudad Real Madrid/Valdebebas- CRM) and describe the burden of COVID-19 on the athletes of the institution. An estimate of the economic cost of the diagnostic tests used was also attempted.

MATERIAL AND METHODS

The Club. Real Madrid is an institution founded as a sports club more than 100 years ago. Throughout its history it has become the most important in the world, recognized and awarded on multiple occasions by international sporting, business, public and private organizations. At present, it has soccer and basketball teams in different categories, starting from 7 years of age up to professionalism, and in men's and women's sections. It currently has 20 soccer teams and 7 basketball teams. Among all the sections, 5 of the teams are professional. On average, each professional soccer team has 25 athletes, 5 coaches and 5 health-care workers (HCW). In the case of basketball, a team has 14 players, 6 coaches and 5 HCW. Overall, we have 600 athletes competing for the club.

The Valdebebas facility. The "Ciudad Real Madrid" (CRM) located at the site of Valdebebas is a sports and administrative complex where most of the club's daily activities take place. It is located in the Valdebebas park, an expansion area of the city of Madrid, very close to the airport. It has an extension of 1,067 hectares, where are housed:

- Twelve soccer fields with official competitive dimensions with a cumulative capacity for 11,000 spectators and 3 fields of particular dimensions for specific trainings.
- Four state-of-the-art basketball courts.
- Two physiotherapy rooms and other installations, including radiology, cardiology and nutrition departments.

In a normal working week. During the study period, the flow of athletes visiting CRM included the 600 athletes and technical team personnel (at least 5 visits per week). Occasional visitors and business visits were virtually eliminated during the study period.

Measures taken for the prevention of COVID were as follows. The measures implemented in Ciudad Real Madrid in response to the outbreak of the COVID-19 pandemic had three fronts of action:

- i) Implementation of conviviality bubbles.

- ii) Preventive management criteria for the coexisting populations in each bubble

- iii) Management criteria for infected individuals and their close contacts.

i) Bubbles of conviviality

It was determined that closed coexistence groups would be established, limiting as much as possible the exchange or contact of activities among them. The criteria to constitute a bubble were the segment of sports facility used, team to which they belong and schedules of use of the facilities.

A segmentation was made by sport use zones and by schedules, assigning each bubble to the corresponding one. Entrance to the facilities was limited exclusively to athletes and persons of strict necessity. Thus, for example, family members and companions could not access the CRM. Any activity that was not strictly necessary and did not interfere with the activity of any coexistence bubble was suspended. For example, the activities of the Real Madrid Foundation, sponsorship events and social recruitment tournaments were cancelled. These activities were only partially recovered when the political and health authorities admitted it, and behaved as an independent bubble.

With respect to the personnel who were to participate in the activities of the various bubbles, it was decided to identify the persons indicated for this purpose and not the specific service in order to limit contacts as much as possible.

With respect to the facilities that were shared by different bubbles, a priority of use criterion was established that conditioned the availability of the facility for the different bubbles.

ii) Preventive management criteria for coexisting populations in each bubble

Some of the measures required in each bubble are summarized below:

- Frequent tests. An average of 3 weekly, including PCR and Panbio Antigen Test.
- Tracing of close contacts.
- Daily Pre-arrival: report of health status and possible symptoms.
- Strict access control to CRM. No access without screening tests (PCR and/or antigen).
- Mandatory use of masks inside the facility except during training.
- Use of changing rooms: First team: training in CRM will change and shower in their rooms in the first team residence. In the games the showers will be used but in shifts of 6 players and in the locker room should be with mask as long as possible.
- For the rest of the categories, avoid showering in the locker room as much as possible. Limit the capacity to 6 players at a time, minimizing the time they stay in the facility. Physiotherapy areas: a person in charge is appointed to ensure that whenever this area is accessed, everyone wears a mask and that

the area has, as far as possible, the doors open so that it is as well ventilated as possible.

- Gymnasiums: groups of a maximum of 6 people, as far apart as possible and with the doors open. A person responsible for proper use was designated.

- Hydrotherapy: use in shifts and respecting priority criteria and designated capacity.

- Dining room: its use was minimized and players were requested to eat at home as much as possible.

- Warehouse and laundry: everyone should wear masks, maximum ventilation and try not to allow the different team's equipment to coincide, with priority given to the first team.

iii) Criteria for the management of infected individuals and their close contacts

- Isolation of infected individuals and testing of close contacts.

- Tracing of close contacts.

- Daily monitoring of the evolution of infected patients by telephone.

- Control test at least 5, 7 and 10 days post-diagnosis.

- Mandatory cardiological check-up for medical discharge. Included troponin, echocardiogram, electrocardiogram and stress test if the cardiologist considered it indicated.

RESULTS

In the time period March 1, 2020 through December 31, 2021 (671 days), 600 athletes attended a median of 5 days per week to train with a median of 480 days of exposure per athlete. This amounts to a total of 288,000 days of exposure to the facility for the 600 athletes.

The age of the athletes ranged from 7 to 42 years. Only 7 athletes had some underlying diseases consisting of diabetes mellitus (2 cases), IgA nephropathy (1 case), high blood pressure (1 case), hypothyroidism (1 case), ulcerative colitis (2 cases).

The number of COVID-19 episodes documented with specific tests was 215 among athletes. This amounts to 0,74 episodes per 1,000 days of exposure. There were no clusters (3 or more cases occurring simultaneously at any time), suggesting little or no transmission in the CRM.

Of the episodes in athletes, none required hospital admission, no deaths occurred and no cases among the athletes have met Long-Term COVID criteria.

Labor, sports and economic impact. The total number of days of sick leave due to COVID-19 in the 600 athletes was 2005, which represented an average of 9.36 +/- 4,26 days per infected athlete.

None of the different teams had to suspend participation in programmed activities due to COVID in the team (3 or more simultaneous cases).

The diagnostic resources employed in the etiological detection of SARS-CoV-2 infection amounted, during the study period, to 40,630 tests divided into 11,307 PCR tests and 29,323 antigen determinations. The economic burden of performing those tests was 1,306.638€. This represents a mean per individual athlete of 67.7 diagnostic tests and an economic burden per athlete of 2,177€.

Taking the first soccer team as an example, the injury retirements during the 18-19, 19-20, 20-21 and 21-22 seasons were 41,43,44 and 38 episodes, respectively.

DISCUSSION

Our study describes a low incidence of COVID-19 in an institution for elite soccer and basketball athletes probably due to the creation of coexistence bubbles and rigorous testing in the different teams. There were no cases of severe COVID among the athletes and none required hospital admission. No sports commitments of any of the teams had to be suspended as there were no outbreaks of internal transmission in any of the teams. No cases of prolonged COVID occurred among these athletes and there was no evidence of a clear deterioration in sports performance attributable to COVID-19.

The policy of creating bubbles of coexistence and the implementation of a very intense systematic of surveillance diagnostic tests resulted in very few days of absence from training, the complete fulfillment of the teams' sporting obligations and a stable level of professional injuries compared with previous seasons.

It is well known that the incidence and severity of COVID-19 increases with factors such as age and the presence of underlying diseases and is particularly severe in patients with immunodeficiencies, hematological diseases and solid tumors [23-32]. In contrast, the incidence and severity of COVID in athlete populations have been very scarcely described as they are not considered a population at risk. Most reports in young athletes emphasize decrease in sports performance after isolation or illness or describe small outbreaks of COVID in this population [14,20,33-45] which was not the case in our experience.

Speaking more specifically about soccer teams, the publications on COVID and soccer often focus on particular aspects such as the impact of quarantine or COVID on team sports performance [18,19,46-48] or the psychological impact of the pandemic on players and their families [33,49]. There are reports on the change in sporting outcomes caused by pandemic conditions, such as a lower win ratio when playing in stadiums without a crowd [17,50-54] and FIFA regulations during the pandemic [55-57].

A few studies make reference to the increased or decreased incidence of muscle injury as a result of decreased activity in confinement [58-60] changes in body composition and muscle mass [15,61] and in the absence of impact on cardiac or pulmonary physiology in players after suffering from COVID [16, 62]. Our data do not reflect any increase in injuries requiring sick leave during the pandemic period.

In a study in several German soccer clubs in which both athletes (1,079 players) and staff (623) were regularly tested, only 8 players (8/1079) and 4 staff (4/623) tested positive during the first PCR rounds before the start of team training and there were no further positive results during the rest of the season. The authors conclude that professional soccer practices and games can be conducted safely during the COVID-19 pandemic if strict hygienic measures are taken that include regular PCR testing [63]. We concur with this view.

In a study by Schumacher et al [64] in a cohort of 1,337 professional soccer players with a strict SARS-CoV2-transmission control program, 85 episodes (6.35%) of COVID occurred that were more related to the players' social activity than to training. None of the patients required hospitalization. We share this opinion.

Outbreaks of COVID cases originating in sports facilities have been very rare among athletes [65-67] although public attendance at a game may have a higher risk among those in attendance [68].

Our approach to the cost study of a very intensive diagnostic testing program, like ours, reveals that the cost of the operation is relatively low and possibly allowed for such rapid detection that no COVID outbreaks actually occurred in any of the coexistence bubbles in our institution. We have not found data on the economic costs of COVID in large sports institutions available for comparison.

Our study has several limitations such as focusing only on a single institution and with sports activities centered on soccer and basketball.

Our study shows that in a large sports institution, a strict program of control measures, with the creation of coexistence bubbles and the performance of very frequent diagnostic tests is effective. There were no internal outbreaks in the institution, the cost of the diagnostic testing program is reasonable and none of the scheduled sports activities had to be cancelled. In the face of potential future waves of SARS-CoV-2 infections, it is necessary to identify effective and ineffective prevention programs, to limit the cancellation of sports activities in very low-risk populations as the soccer and basketball players.

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CONFLICT OF INTEREST

Authors declare no conflict of interest.

REFERENCES

- Long B, Carius BM, Chavez S, Liang SY, Brady WJ, Koyfman A, et al. Clinical update on COVID-19 for the emergency clinician: Presentation and evaluation. *Am J Emerg Med.* 2022;54:46-57.
- Rahman MM, Masum MHU, Wajed S, Talukder A. A comprehensive review on COVID-19 vaccines: development, effectiveness, adverse effects, distribution and challenges. *Virusdisease.* 2022:1-22.
- Yelin D, Margalit I. Challenges and Management of Long COVID in Individuals with Hematological Illnesses. *Acta Haematol.* 2022; 145: 275-281.
- Basu D, Chavda VP, Mehta AA. Therapeutics for COVID-19 and post COVID-19 complications: An update. *Curr Res Pharmacol Drug Discov.* 2022:100086.
- McIntyre PB, Aggarwal R, Jani I, Jawad J, Kochhar S, MacDonald N, et al. COVID-19 vaccine strategies must focus on severe disease and global equity. *Lancet.* 2022;399(10322):406-10.
- Peeling RW, Heymann DL, Teo YY, Garcia PJ. Diagnostics for COVID-19: moving from pandemic response to control. *Lancet.* 2022; 399 (1036):757-768.
- Lu Y, Jiao Y, Graham DJ, Wu Y, Wang J, Menis M, et al. Risk factors for COVID-19 deaths among elderly nursing home Medicare beneficiaries in the pre-vaccine period. *J Infect Dis.* 2022; 225:567-577.
- Guillon A, Laurent E, Godillon L, Kimmoun A, Grammatico-Guillon L. Long-term mortality of elderly patients after intensive care unit admission for COVID-19. *Intensive Care Med.* 2021;47(6):710-2.
- Brown LK, Moran E, Goodman A, Baxendale H, Birmingham W, Buckland M, et al. Treatment of chronic or relapsing COVID-19 in immunodeficiency. *J Allergy Clin Immunol.* 2022; 149: 557-561.
- Shields AM, Burns SO, Savic S, Richter AG. COVID-19 in patients with primary and secondary immunodeficiency: The United Kingdom experience. *J Allergy Clin Immunol.* 2021;147(3):870-5.e1.
- Weinkove R, McQuilten ZK, Adler J, Agar MR, Blyth E, Cheng AC, et al. Managing haematology and oncology patients during the COVID-19 pandemic: interim consensus guidance. *Med J Aust.* 2020; 212:481-489.
- Zhao H, Du S, Cai J, Mao Y. Recommendations for medical care of oncological patients during the COVID-19 epidemic: experiences from China. *Updates Surg.* 2020; 72: 235-236.
- Onesti CE, Tagliamento M, Curigliano G, Harbeck N, Bartsch R, Wildiers H, et al. Expected Medium- and Long-Term Impact of the COVID-19 Outbreak in Oncology. *JCO Glob Oncol.* 2021;7:162-72.
- Pillay L, Janse van Rensburg DCC, Jansen van Rensburg A, Ramagole DA, Holtzhausen L, Dijkstra HP, et al. Nowhere to hide: the significant impact of coronavirus disease 2019 (COVID-19) measures on elite and semi-elite South African athletes. *J Sci Med Sport.* 2020;23: 670-679.
- Dauty M, Menu P, Fouasson-Chailloux A. Effects of the COVID-19 confinement period on physical conditions in young elite soccer players. *J Sports Med Phys Fitness.* 2021;61(9):1252-7.
- Di Paco A, Mazzoleni S, Vitacca M, Comini L, Ambrosino N. Lung function and ventilatory response to exercise in asymptomatic elite soccer players positive for COVID-19. *Pulmonology.* 2022;28: 148-151.
- Mascia G, Pescetelli F, Baldari A, Gatto P, Seitun S, Sartori P, et al. Interpretation of elevated high-sensitivity cardiac troponin I in elite soccer players previously infected by severe acute respiratory syndrome coronavirus 2. *Int J Cardiol.* 2021;326:248-51.

18. Pucsok JM, Kovács M, Ráthonyi G, Pocsai B, Balogh L. The Impact of COVID-19 Lockdown on Agility, Explosive Power, and Speed-Endurance Capacity in Youth Soccer Players. *Int J Environ Res Public Health*. 2021;18(18): 9604.
19. Rampinini E, Donghi F, Martin M, Bosio A, Riggio M, Maffioletti NA. Impact of COVID-19 Lockdown on Serie A Soccer Players' Physical Qualities. *Int J Sports Med*. 2021;42(10):917-23.
20. Watson AM, Haraldsdottir K, Biese KM, Goodavish L, Stevens B, McGuine TA. COVID-19 in US Youth Soccer Athletes During Summer 2020. *J Athl Train*. 2021;56(6):542-7.
21. Waldén M, Ekstrand J, Häggglund M, McCall A, Davison M, Hallén A, et al. Influence of the COVID-19 Lockdown and Restart on the Injury Incidence and Injury Burden in Men's Professional Football Leagues in 2020: The UEFA Elite Club Injury Study. *Sports Med Open*. 2022;8(1):67.
22. Unnithan VB, Drust B, Brow C, Bakhshi A, Mason L, Weston M. Influence of the Covid 19 pandemic on changes in aerobic fitness and injury incidence in elite male soccer players. *J Sports Med Phys Fitness*. 2022. DOI: 10.23736/50022-4707.22.13929.
23. Tzotzos SJ, Fischer B, Fischer H, Zeitlinger M. Incidence of ARDS and outcomes in hospitalized patients with COVID-19: a global literature survey. *Crit Care*. 2020;24(1):516.
24. Upshaw TL, Brown C, Smith R, Perri M, Ziegler C, Pinto AD. Social determinants of COVID-19 incidence and outcomes: A rapid review. *PLoS One*. 2021;16(3):e0248336.
25. Ruscitti P, Conforti A, Cipriani P, Giacomelli R, Tasso M, Costa L, et al. Pathogenic implications, incidence, and outcomes of COVID-19 in autoimmune inflammatory joint diseases and autoinflammatory disorders. *Adv Rheumatol*. 2021;61(1):45.
26. Morales-Ortega A, García de Tena J, Frutos-Pérez B, Jaenes-Barrios B, Farfán-Sedano AI, Canales-Albendea M, et al. COVID-19 in patients with hematological malignancies: Considering the role of tyrosine kinase inhibitors. *Cancer*. 2021; 127: 1937-1938.
27. Vijenthira A, Gong IY, Fox TA, Booth S, Cook G, Fattizzo B, et al. Outcomes of patients with hematologic malignancies and COVID-19: A systematic review and meta-analysis of 3377 patients. *Blood*. 2020; 136:2881-2882.
28. Cattaneo C, Daffini R, Pagani C, Salvetti M, Mancini V, Borlenghi E, et al. Clinical characteristics and risk factors for mortality in hematologic patients affected By COVID-19. *Cancer*. 2020; 126: 5069-5076.
29. Hakki M, Rattray RM, Press RD. The clinical impact of coronavirus infection in patients with hematologic malignancies and hematopoietic stem cell transplant recipients. *J Clin Virol*. 2015;68:1-5.
30. Saab R, Obeid A, Gachi F, Boudiaf H, Sargsyan L, Al-Saad K, et al. Impact of the coronavirus disease 2019 (COVID-19) pandemic on pediatric oncology care in the Middle East, North Africa, and West Asia Region: A report from the Pediatric Oncology East and Mediterranean (POEM) Group. *Cancer*. 2020; 126: 4235-4245.
31. Anonymous. Oncology and COVID-19. *Bull Acad Natl Med*. 2020; 204: e36-e37.
32. Jazieh AR, Alenazi TH, Alhejazi A, Al Safi F, Al Olayan A. Outcome of Oncology Patients Infected With Coronavirus. *JCO Glob Oncol*. 2020;6:471-5.
33. Maurice J, Devonport TJ, Knight CJ. Toward Improved Triadic Functioning: Exploring the Interactions and Adaptations of Coaches, Parents and Athletes in Professional Academy Soccer Through the Adversity of COVID-19. *Front Psychol*. 2021;12:609631.
34. Rico-González M, Pino-Ortega J, Clemente FM, Bustamante-Hernández N. Relationship between Training Load Management and Immunoglobulin A to Avoid Immunosuppression after Soccer Training and Competition: A Theoretical Framework Based on COVID-19 for Athletes' Healthcare. *Healthcare (Basel)*. 2021;9(7).
35. Hendrickson BS, Stephens RE, Chang JV, Amburn JM, Pierotti LL, Johnson JL, et al. Cardiovascular Evaluation After COVID-19 in 137 Collegiate Athletes: Results of an Algorithm-Guided Screening. *Circulation*. 2021;143(19):1926-8.
36. Poppas A, Chung EH, Kovacs R. COVID-19 and the Athlete: Gaining Ground But Not Yet at the Finish. *J Am Coll Cardiol*. 2021;77(10):1368-71.
37. Correction to: COVID-19 Myocardial Pathology Evaluation in Athletes with Cardiac Magnetic Resonance (COMPETE CMR). *Circulation*. 2021;143(6):e238.
38. Vaughan RS, Edwards EJ, MacIntyre TE. Mental Health Measurement in a Post Covid-19 World: Psychometric Properties and Invariance of the DASS-21 in Athletes and Non-athletes. *Front Psychol*. 2020;11:590559.
39. Clark DE, Parikh A, Dendy JM, Diamond AB, George-Durrett K, Fish FA, et al. COVID-19 Myocardial Pathology Evaluation in Athletes with Cardiac Magnetic Resonance (COMPETE CMR). *Circulation*. 2021; 143: 609-612.
40. Yousfi N, Bragazzi NL, Briki W, Zmijewski P, Chamari K. The COVID-19 pandemic: how to maintain a healthy immune system during the lockdown - a multidisciplinary approach with special focus on athletes. *Biol Sport*. 2020;37(3):211-6.
41. Stais P, Salloum O, Kühle D, Fisteag S, Kambartel K, Veelken D, et al. [48-Year-Old Triathlete with Severe COVID-19 Pneumonia: Successful and Safe Treatment with Oxygen and CPAP]. *Pneumologie*. 2020;74(7):417-22.
42. Pillay L, Janse van Rensburg DCC, Jansen van Rensburg A, Ramagole DA, Holtzhausen L, Dijkstra HP, et al. Nowhere to hide: The significant impact of coronavirus disease 2019 (COVID-19) measures on elite and semi-elite South African athletes. *J Sci Med Sport*. 2020; 23: 670-679.
43. Toresdahl BG, Asif IM. Coronavirus Disease 2019 (COVID-19): Considerations for the Competitive Athlete. *Sports Health*. 2020:1941738120918876.
44. Tasca JS, Bianchi G, Girardello A, Lucchini A, Cappelli C. Cardiac involvement in athletes infected by SARS COV-2 disease. *Sci Sports*. 2022;37(3):167-75.
45. Parpa K, Michaelides M. Aerobic capacity of professional soccer players before and after COVID-19 infection. *Sci Rep*. 2022;12(1):11850.
46. Savicevic AJ, Nincevic J, Versic S, Cuschieri S, Bandalovic A, Turic A, et al. Performance of Professional Soccer Players before and after COVID-19 Infection; Observational Study with an Emphasis on Graduated Return to Play. *Int J Environ Res Public Health*. 2021;18(21).

47. Radzimiński Ł, Padrón-Cabo A, Konefał M, Chmura P, Szwarc A, Jastrzębski Z. The Influence of COVID-19 Pandemic Lockdown on the Physical Performance of Professional Soccer Players: An Example of German and Polish Leagues. *Int J Environ Res Public Health*. 2021;18(16).
48. Mazza D, Annibaldi A, Princi G, Arioli L, Marzilli F, Monaco E, et al. Injuries During Return to Sport After the COVID-19 Lockdown: An Epidemiologic Study of Italian Professional Soccer Players. *Orthop J Sports Med*. 2022;10(6):23259671221101612.
49. Esteves NS, de Brito MA, Müller VT, Brito CJ, Valenzuela Pérez DI, Slimani M, et al. COVID-19 Pandemic Impacts on the Mental Health of Professional Soccer: Comparison of Anxiety Between Genders. *Front Psychol*. 2021;12:765914.
50. Link D, Anzer G. How the COVID-19 Pandemic has Changed the Game of Soccer. *Int J Sports Med*. 2022; 43:83-89.
51. Sedeaud A, De Laroche Lambert Q, Schipman J, Toussaint JF. The COVID-19 Pandemic Impact on Away and Home Victories in Soccer and Rugby Union. *Front Sports Act Living*. 2021;3:695922.
52. Tilp M, Thaller S. Covid-19 Has Turned Home Advantage Into Home Disadvantage in the German Soccer Bundesliga. *Front Sports Act Living*. 2020;2:593499.
53. Benz LS, Lopez MJ. Estimating the change in soccer's home advantage during the Covid-19 pandemic using bivariate Poisson regression. *Adv Stat Anal*. 2021:1-28.
54. García-Aliaga A, Marquina M, Cerdón-Carmona A, Sillero-Quintana M, de la Rubia A, Refoyo Román I. Comparative Analysis of Soccer Performance Intensity of the Pre-Post-Lockdown COVID-19 in LaLiga™. *Int J Environ Res Public Health*. 2021;18(7).
55. Mota GR, Santos IA, Marocolo M. Change in Soccer Substitutions Rule Due to COVID-19: Why Only Five Substitutions? *Front Sports Act Living*. 2020;2:588369.
56. Lima Y, Denerel N, Öz ND, Senisik S. The psychological impact of COVID-19 infection on athletes: example of professional male football players. *Sci Med Footb*. 2021;5(sup1):53-61.
57. Basu S, Higgins R, Malhotra A, Ahmad I. Surveillance for COVID-19 in the English Football League 2019-2020. *Sci Med Footb*. 2021;5(sup1):13-6.
58. Orhant E, Chapellier JF, Carling C. Injury rates and patterns in French male professional soccer clubs: a comparison between a regular season and a season in the Covid-19 pandemic. *Res Sports Med*. 2021:1-11.
59. Marotta N, A DES, Gimigliano A, Demeco A, Moggio L, Vescio A, et al. Impact of COVID-19 lockdown on the epidemiology of soccer muscle injuries in Italian Serie A professional football players. *J Sports Med Phys Fitness*. 2022; 62:356-360.
60. Seshadri DR, Thom ML, Harlow ER, Drummond CK, Voos JE. Case Report: Return to Sport Following the COVID-19 Lockdown and Its Impact on Injury Rates in the German Soccer League. *Front Sports Act Living*. 2021;3:604226.
61. Campa F, Bongiovanni T, Trecroci A, Rossi A, Greco G, Pasta G, et al. Effects of the COVID-19 Lockdown on Body Composition and Bioelectrical Phase Angle in Serie A Soccer Players: A Comparison of Two Consecutive Seasons. *Biology (Basel)*. 2021;10(11).
62. Peidro R, Argemi R, Batista J, Logioco L, Perez De Arenaza D, Bortman G. [Cardiac magnetic resonance and follow up of professional soccer players recovering from COVID-19]. *Medicina (B Aires)*. 2021;81(4):491-5.
63. Meyer T, Mack D, Donde K, Harzer O, Krutsch W, Rössler A, et al. Successful return to professional men's football (soccer) competition after the COVID-19 shutdown: a cohort study in the German Bundesliga. *Br J Sports Med*. 2021;55(1):62-6.
64. Schumacher YO, Tabben M, Hassoun K, Al Marwani A, Al Hussein I, Coyle P, et al. 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;55(19):1092-8.
65. Teran RA, Ghinai I, Gretsich S, Cable T, Black SR, Green SJ, et al. COVID-19 Outbreak Among a University's Men's and Women's Soccer Teams - Chicago, Illinois, July-August 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(43):1591-4.
66. Choi HJ, Kim HJ, Seo G. Overseas Air Medical Repatriation of National Soccer Players Infected With Coronavirus Disease 2019 and Contacted Staff From Austria to South Korea. *Air Med J*. 2021;40(4):282-6.
67. Drezner JA, Drezner SM, Magner KN, Ayala JT. COVID-19 Surveillance in Youth Soccer During Small Group Training: A Safe Return to Sports Activity. *Sports Health*. 2021;13(1):15-7.
68. Gómez JP, Mironov M. Using Soccer Games as an Instrument to Forecast the Spread of COVID-19 in Europe. *Financ Res Lett*. 2021;43:101992.