Pulmonology 28 (2022) 148–151

PULMONOLOGY

www.journalpulmonology.org

LETTER TO THE EDITOR

Lung function and ventilatory response to exercise in asymptomatic elite soccer players positive for COVID-19

Dear Editor

Individuals recovering from SARS-CoV-2 (COVID-19) infection[1] show impaired lung function, particularly diffusion capacity (DLCO).[2] In addition, high prevalence of muscle weakness and impairment in physical performance have been reported in individuals without any prior motor limitations.[3,4] While data report cardiac injury among professionals athletes,[5-7] less is known about the potential damage to lung function and ventilatory response to exercise in asymptomatic elite athletes. Soccer is a highly physiologically demanding sport, with additional stress resulting from frequent matches and high load training sessions, ventilatory parameters playing a role in performance.[8,9]

In asymptomatic professional soccer players, we retrospectively report data of lung function and cardiopulmonary exercise tests after return to negativity to nasal/throat swabs for COVID-19 by polymerase chain reaction. We compare the findings with data of evaluations before the start of the sport season for license to professional activity.

The study was approved by the Ethical Committee of ICS Maugeri (2515 CE, February 9th, 2021) and participants signed the informed consent for the scientific use of their data.

Players underwent daily swabs to assess return to Covid negative. Before the sport season (T_0) and the day immediately after return to Covid negative (T_1: 14.3±5.4 days from testing positive), participants underwent flow-volume curve and cardiopulmonary incremental exercise test on treadmill according to standards [8,9] to be permitted to resume activity. Researchers performing analysis of data but not those performing assessments were blind to players' identity.

Data are shown as mean ± standard deviation (SD). A Student's t-test was carried out for differences between T_1 and T_0. In case of failure of normality test, a Mann-Whitney Rank Sum test was performed. Linear regressions between days of Covid positive and velocity at peak exercise (VEL_{peak}) and velocity at anaerobic threshold (VEL_{AT}) respectively, were also computed. A p value <0.05 was considered as statistically significant.

Sixteen players (22.9 ± 4.5 years; Body-Mass Index: 23.4 ± 1.9 Kg/m^2) from three teams were evaluated: as expected, none reported smoking habit or any relevant disease, with negative chest physical examination. After comprehensive evaluation, including cardiological tests, all players could return to sport professional activity.

As compared to T_0, at T_1 there was no significant reduction in dynamic lung volumes (Table 1). However, players showed a significant mean reduction in VEL_{peak} and VEL_{AT}, with a significant increase in oxygen consumption at anaerobic threshold to peak oxygen consumption ratio (Table 2). There was no significant correlation between days when Covid positive and T_1-T_0 changes in VEL_{peak} or VEL_{AT}.

We have no data for immediately before infection, therefore we had to compare data after return to Covid negative with pre sport season evaluation. It has been reported that a competitive season improves ventilatory profile response to exercise in elite athletes.[9] Therefore, we may argue that after the prolonged period of training and competitions performed before pandemic, the physical performance of our players would have been higher than at T_0, and as a consequence the differences with post return to Covid negative even greater.

What could be the cause of reduced physical performance in these individuals? It may be argued that rest and lack of training due to imposed quarantine (at least while Covid positive) may have influenced results. However, there was no significant correlation between days when Covid positive (and rest) and reduction in exercise velocity. In addition, due to the lack of assessment of DLCO we cannot exclude any lung involvement beyond dynamic lung volumes.

We were unable to report any data of cardiac function. However, we know that all these players were allowed to return to their activity after cardiological evaluation. A large screening has reported a 3.8% prevalence of

https://doi.org/10.1016/j.pulmoe.2021.11.002

Table 1 Individual and mean data of lung function.

	Player.	FEV_1, L	FVC, L	FEV_1/FVC, %	MEF_{25}, L/sec	MEF_{50}, L/sec	MEF_{75}, L/sec
T0	1	5.20	5.68	91.5	2.48	6.02	8.00
T1		5.12	6.04	84.8	2.46	6.26	10.01
T0	2	4.31	5.51	78.2	1.71	4.23	6.77
T1		4.44	5.87	75.6	1.58	4.32	6.35
T0	3	4.59	5.34	86.0	2.54	4.71	8.19
T1		4.41	5.03	87.7	2.49	3.94	7.72
T0	4	4.28	5.07	84.4	2.15	4.38	7.14
T1		4.55	5.35	85.0	2.54	4.87	8.29
T0	5	4.26	5.57	76.5	1.51	4.18	7.76
T1		4.17	5.33	78.2	1.53	4.05	8.35
T0	6	5.15	6.11	84.3	2.50	6.27	8.75
T1		5.11	6.24	81.9	2.49	5.47	10.13
T0	7	5.08	6.68	76.0	2.51	4.48	7.42
T1		5.32	7.23	73.6	2.25	4.65	7.84
T0	8	4.70	4.88	96.3	5.33	7.59	10.27
T1		4.90	5.40	90.7	3.49	7.57	10.26
T0	9	4.78	4.89	97.7	5.82	6.76	9.97
T1		5.53	5.94	93.1	5.66	6.89	7.77
T0	10	4.53	5.28	85.8	2.21	5.91	9.03
T1		5.00	5.31	94.2	2.30	5.74	9.52
T0	11	5.31	5.97	88.9	3.35	7.72	13.31
T1		5.31	5.94	89.4	3.77	8.44	14.31
T0	12	5.56	6.38	87.1	3.35	7.02	10.72
T1		5.76	7.20	80.0	2.57	5.91	10.87
T0	13	5.13	5.13	100.0	3.11	7.05	6.69
T1		5.27	6.08	86.7	2.94	6.97	8.34
T0	14	5.14	6.42	80.1	2.30	5.31	9.71
T1		4.95	6.30	78.6	2.01	5.20	9.11
T0	15	3.84	3.86	99.5	2.11	5.25	8.05
T1		3.78	3.80	99.5	3.75	6.58	7.30
T0	16	5.10	5.89	86.6	2.09	7.33	10.67
T1		5.21	6.15	84.7	2.62	7.53	9.92
(ì T0	mean±SD	4.8 ± 0.5	5.5 ± 0.7	86.5 ± 1.6	2.8 ± 1.2	5.9 ± 1.3	8.9 ± 1.8
(T1	mean±SD	4.9 ± 0.5	5.8 ± 0.8	86.5 ± 0.5	2.8 ± 1.0	5.9 ± 1.4	9.1 ± 1.9
P Value		0.077	0.316	0.986	0.692	0.981	0.735

Abbreviations. FEV1, Forced Expiratory Volume at 1 second; FVC, Forced Vital Capacity; MEF_{75}, maximal expiratory flow at 75% of FVC; MEF_{50}, Maximal Expiratory Flow at 50% of FVC; MEF_{25}, Maximal Expiratory Flow at 25% of FVC.

abnormalities in cardiologic screening of professional athletes 19±17 days after a positive test.[6] In another study 2.3% of athletes with recent infection were diagnosed with clinical and subclinical myocarditis.[7] Our study seems to suggest the importance of assessing lung function in the comprehensive evaluation of elite athletes.

Our study has the limitations of the small sample size and the flaws of a retrospective design like the lack of assessment of DLCO (or a chest CT scan), respiratory or peripheral muscle function and the lack of cardiological data.

In conclusion, with the above limitations, this study suggests that reduction in exercise performance in professional soccer players after return to negativity for COVID-19 is not associated with a reduction in dynamic lung volumes. Despite the relatively small sample size and the possible lack of external validity of these results, our findings may be useful for guiding sport medical supervisors of these players. Our study indicates also the need to assess lung function for a full evaluation of these individuals. However, to exclude any potential lung involvement, assessment also of DLCO should be mandatory.

Declaration of competing interest

Nicolino Ambrosino is the Chief Editor of Pulmonology. The other authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Table 2 Individual and mean data of exercise test.

	Player.	VEL_{AT}, km/h	HR_{AT}, bpm	VEL_{peak}, km/h	HR_{peak}, bpm	$VO_{2\ AT}$, ml/kg/min	$VO_{2\ peak}$, ml/kg/min	$VO_{2\ AT}$/ $VO_{2\ Peak}$,%	VE_{AT}, L/min	VE_{peak}, L/min
T0	1	17.9	172	21.8	170	55.5	63.3	87.7	154	205
T1		15.9	178	20.2	193	51.9	51.6	100.6	142	179
T0	2	17.1	183	18.5	188	48.8	54.6	89.4	83	136
T1		15.7	171	17.5	181	55.9	60.0	93.2	106	135
T0	3	16.2	174	21.7	194	45.0	62.0	72.6	95	159
T1		15.0	173	20.2	199	46.2	64.2	72.0	78	173
T0	4	15.2	172	18.8	176	46.2	53.6	86.2	101	153
T1		13.9	169	18.4	192	43.4	49.8	87.1	102	147
T0	5	15.1	172	18.9	193	49.8	50.9	97.8	114	149
T1		15.7	168	19.8	190	54.3	53.9	100.7	117	158
T0	6	16.2	178	21.0	198	47.5	53.7	88.5	98	175
T1		13.2	178	15.1	186	46.5	44.7	104.0	90	78
T0	7	16.2	177	20.9	191	59.4	67.4	88.1	113	197
T1		15.7	174	17.8	182	64.0	58.7	109.0	129	155
T0	8	14.9	188	18.9	199	47.3	52.5	90.1	119	170
T1		15.9	182	18.9	194	50.5	48.9	103.3	124	154
T0	9	15.8	169	20.2	178	56.9	60.1	94.7	127	178
T1		16.0	172	20.0	181	55.1	62.8	87.7	123	176
T0	10	14.2	148	19.0	179	43.3	50.5	85.7	93	170
T1		15.2	152	17.1	166	51.4	54.3	94.7	140	137
T0	11	14.4	163	18.9	190	49.2	53.6	91.8	105	182
T1		13.4	179	18.5	209	50.2	46.3	108.4	115	181
T0	12	15.0	169	19.2	190	41.8	52.2	80.1	115	185
T1		13.8	168	18.9	189	43.0	53.7	80.1	110	183
T0	13	14.8	167	20.3	183	43.5	60.0	72.5	99	187
T1		15.1	158	18.8	174	51.1	59.0	86.6	120	168
T0	14	18.5	185	20.8	195	52.0	49.3	105.5	129	140
T1		14.7	169	18.9	185	48.9	50.7	96.4	126	144
T0	15	15.9	178	20.7	202	50.1	44.0	113.9	97	117
T1		15.3	183	17.1	189	39.7	52.1	76.2	75	123
T0	16	16.1	180	19.7	197	52.3	55.6	94.1	139	192
T1		13.9	164	19.0	188	50.9	52.5	97.0	116	174
T0	mean±SD	15.7 ± 1.3	172.0 ± 11.0	19.9 ± 1.1	188.2 ± 9.5	49.3 ± 5.0	55.3 ± 5.8	68.4 ± 10.9	115.5 ± 18.2	169.5 ± 23.8
T1	mean±SD	14.9 ± 0.9	169.0 ± 9.7	18.5 ± 1.3	186.0 ± 10.8	50.2 ± 5.8	53.5 ± 5.8	76.8 ± 10.6	113.4 ± 18.8	153.4 ± 26.6
P Value		0.032	0.570	0.002	0.570	0.474	0.441	0.029	0.762	0.074

Abbreviations. VEL_{AT}, exercise velocity at anaerobic threshold; HR_{AT}, heart rate at anaerobic threshold; VEL_{peak}: velocity at peak exercise; HR_{peak}, heart rate at peak exercise; $VO_{2\ AT}$, oxygen consumption at anaerobic threshold; VO_{2peak}, oxygen consumption at peak exercise; VE_{AT}, Minute Ventilation at anaerobic threshold; VE_{peak}, minute ventilation at peak exercise.

Funding information

This work was partly supported by the "Ricerca Corrente" funding scheme of the Italian Ministry of Health.

References

1. Winck JC, Ambrosino N. COVID-19 pandemic and non invasive respiratory management: every goliath needs a david. An evidence based evaluation of problems. Pulmonology. 2020;26:213–20. https://doi.org/10.1016/j.pulmoe.2020.04.013.
2. Torres-Castro R, Vasconcello-Castillo L, Alsina-Restoy X, et al. Respiratory function in patients post-infection by COVID-19: a systematic review and meta-analysis. Pulmonology. 2021;27:328–37. https://doi.org/10.1016/j.pulmoe.2020.10.013.
3. Simonelli C, Paneroni M, Vitacca M, Ambrosino N. Measures of physical performance in COVID-19 patients: a mapping review. Pulmonology. 2021;27:518–28. https://doi.org/10.1016/j.pulmoe.2021.06.005.
4. Paneroni M, Simonelli C, Saleri M, et al. Muscle strength and physical performance in patients without previous disabilities recovering from COVID-19 pneumonia. Am J Phys Med Rehabil. 2021;100:105–9. https://doi.org/10.1097/PHM.0000000000001641.
5. Gervasi SF, Pengue L, Damato L, et al. Is extensive cardiopulmonary screening useful in athletes with previous asymptomatic or mild SARS-CoV-2 infection? Br J Sports Med. 2021;55:54–61. https://doi.org/10.1136/bjsports-2020-102789.
6. Martinez MW, Tucker AM, Bloom OJ, et al. Prevalence of inflammatory heart disease among professional athletes with prior COVID-19 infection who received systematic return-to-play cardiac screening. JAMA Cardiol. 2021;6:745–52. https://doi.org/10.1001/jamacardio.2021.0565.
7. Daniels CJ, Rajpal S, Greenshields JT, et al. Prevalence of clinical and subclinical myocarditis in competitive athletes with recent SARS-CoV-2 infection: results from the big ten COVID-19 cardiac registry. JAMA Cardiol. 2021;6:1078-1087. Doi 10.1001/jamacardio.2021.2065
8. Di Paco A, Catapano GA, Vagheggini G, Mazzoleni S, Micheli ML, Ambrosino N. Ventilatory response to exercise of elite soccer players. Multidiscip Respir Med. 2014;9:20. https://doi.org/10.1186/2049-6958-9-20.
9. Di Paco A, Dubé BP, Laveneziana P. Changes in ventilatory response to exercise in trained athletes: respiratory physiological benefits beyond cardiovascular performance. Arch Bronconeumol. 2017;53:237–44. https://doi.org/10.1016/j.arbres.2016.11.023.

A. Di Paco[a], S. Mazzoleni[b], M. Vitacca[c,*], L. Comini[d], N. Ambrosino[e]

[a] *Lung Unit, Casa di Cura San Rossore, Pisa, Italy*
[b] *Department of Electrical and Information Engineering, Politecnico di Bari, Bari, Italy*
[c] *Respiratory Rehabilitation of the Institute of Lumezzane, Istituti Clinici Scientifici Maugeri IRCCS, Lumezzane, Brescia, Italy*
[d] *Scientific Direction of the Institute of Lumezzane, Istituti Clinici Scientifici Maugeri IRCCS, Lumezzane, Brescia, Italy*
[e] *Respiratory Rehabilitation of the Institute of Montescano, Istituti Clinici Scientifici Maugeri IRCCS, Montescano, Pavia, Italy*

[*] Correspondence author at: Istituti Clinici Scientifici Maugeri IRCCS, Respiratory Rehabilitation of the Institute of Lumezzane, Brescia, Italy.
E-mail address: michele.vitacca@icsmaugeri.it (M. Vitacca).
Received 29 October 2021; Accepted 1 November 2021
Available online 18 November 2021