Association between SARS-COV-2 infection and muscle strain injury occurrence in elite male football players: a prospective study of 29 weeks including three teams from the Belgian professional football league

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Accepted 19 April 2022

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To cite: Wezenbeek E, Denolf S, Willems TM, *et al*. *Br J Sports Med* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/bjsports-2021-104595

ABSTRACT

Objectives The aim of this study was to investigate the association between SARS-CoV-2 infection and muscle strain injury in elite athletes.

Methods A prospective cohort study in three Belgian professional male football teams was performed during the first half of the 2020–2021 season (June 2020–January 2021). Injury data were collected using established surveillance methods. Assessment of SARS-CoV-2 infection was performed by a PCR test before each official game.

Results Of the 84 included participants, 22 were infected with SARS-CoV-2 and 14 players developed a muscle strain during the follow-up period. Cox's proportional hazards regression analyses demonstrated a significant association between SARS-CoV-2 infection and the development of muscle strain (HR 5.1; 95% CI 1.1 to 23.1; p=0.037), indicating an increased risk of developing muscle strains following SARS-CoV-2 infection. All athletes who sustained a muscle strain after infection were injured within the first month (15.71±11.74 days) after sports resumption and completed a longer time in quarantine (14.57±6.50 days) compared with the infected players who did not develop a muscle strain (11.18±5.25 days).

Conclusion This study reported a five times higher risk of developing a muscle strain after a SARS-CoV-2 infection in elite male football players. Although this association should be examined further, it is possible that short-term detraining effects due to quarantine, and potentially pathological effects of the SARS-CoV-2 infection are associated with a higher risk of muscle strain injury.

INTRODUCTION

Currently elite athletes involved in contact sports, such as professional football (soccer) players, train and play in exceptional conditions due to the pandemic caused by the SARS-CoV-2, which is the coronavirus that causes COVID-19.[1] Patients with SARS-CoV-2 infection can experience a range of clinical manifestations, from no symptoms to critical illness. Previous research showed that SARS-CoV-2 mainly spreads via respiratory droplets and direct contact and disease severity might be impacted by the viral load incurred at the time of infection.[2] In team sports such as football, personal contact between players is inevitable and the commonly suggested prevention measures of 'social distancing' cannot occur. In addition, the heavy, unprotected breathing during exercise generates more droplets than normal respiration, increasing the risk of viral exposure.[3]

An important approach to containing the SARS-CoV-2 outbreak is the requirement of infected patients to remain at home in quarantine, thereby minimising physical contact and reducing the spread of the virus. This mandatory quarantine period for infected athletes could lead to a certain level of short-term detraining, resulting in a loss of training induced morphological and physiological adaptations in the muscular and the cardiovascular system.[4] In addition, after the acute phase of COVID-19, there are now consistent reports that COVID-19 positive athletes may present persistent and residual symptoms after quarantine, including cough, tachycardia and (extreme) fatigue.[5] Fatigue is a frequently reported symptom of COVID-19 but is also stated as a potentially significant risk factor for muscle injury.[6] Thus, fatigue in combination with short-term detraining effects due to quarantine could increase the risk of sustaining muscle strain injury on return to sport. Keeping the consequences of COVID-19 disease in mind, sufficient periods of rest after infection and resolution of symptoms is highly recommended.[5 7] Unfortunately, this is not always possible in the context of the competition season, certainly in pandemic times, when athlete availability can be highly compromised.[8]

Although COVID-19 predominantly affects the cardiorespiratory system,[9] SARS-CoV-2 infection has also shown to compromise peripheral muscle function by inducing capillary flow disturbances, limiting oxygen uptake and limiting the muscle's metabolic function.[10] In a high-intensity intermittent sport such as football, the physical demands are complex, encompassing both high endurance capacity and fatigue resistance during high-intensity exercise.[11 12] These sport-specific performance demands necessitate footballers to rely on an optimal metabolic and muscle oxidative capacity since the endurance performance in a football game is shown to be related to muscle oxidative capacity.[13] Therefore, the previously described pathological effects of COVID-19 might increase the risk of developing a muscle strain injury. This is in line with previous research that already reported injury rate to increase more than threefold following the first lockdown (0.84 injuries per game vs 0.27 injuries per game), with muscle strain injuries reported most frequently.[14] Therefore, the aim of this study was to investigate the association between SARS-CoV-2 infection and muscle strain injury in elite athletes.

MATERIALS AND METHODS

Study design

A prospective cohort study in Belgian professional male football was performed for 29 weeks during the first half of the 2020–2021 season. Athlete characteristics such as age, height, weight and previous injury were recorded by each team. Next, all players were monitored for injuries and SARS-CoV-2 infections during the first half of the season. Injury registration was conducted by each team's medical staff. An overview of the infected players was documented by the team's physician, including the days absent from training and the severity of COVID-19 symptoms (asymptomatic, mild, medium and severe). The timing of athletes demonstrating a positive PCR test differed substantially between players. The number of days of quarantine and the number of days between return to play clearance (following quarantine) until muscle strain injury were registered for each player. To ensure accuracy of data collection, all teams were provided with a standardised form to record both injury registration data and data pertaining to the SARS-CoV-2 infection. All reports were checked every month by the authors (EW and SD) and, if necessary, feedback was sent to the teams to check for missing or unclear data. Time of exposure for training sessions and games were recorded at an individual level using global positioning system (GPS) data. Each player wore a GPS device mounted on their chest strap for all training and matches. Data were downloaded daily.

Participants

Three teams of the Jupiler Pro League (highest professional football league in Belgium), with a total of 109 players, participated in this study. Eight goalkeepers were excluded from this study due to required physical characteristics for the larger prospective study described below. In addition, 17 players transferred to another team quickly after the start of the season and were therefore excluded from further analyses due to incomplete data. The three included teams were selected based on their reliable data collection in previous collaborations. First the staff and then all athletes were informed on the original study design and aim. All players consented to participate.

Patient and public involvement

This study was part of a larger prospective cohort study performed in three professional male football teams investigating the association between preseason screening, performance during the season and, injury occurrence. The research question of this study was developed—in collaboration with the medical staff of each team as part of a reintroduction of the original study which was delayed due to the COVID-19 pandemic. Therefore, all analyses were performed on a sample of convenience. The medical staff of each team was also involved in the injury registration and the SARS-CoV-2 infection data collection. The board, the staff and all players provided consent to analyse the COVID-19-related data and they were all informed of the study results.

Injury registration

Injury was defined as any injury occurring during a scheduled training session or match causing the player to miss the next training session or match (ie, time-loss definition).[15] Each absence of training and/or match due to injury was registered by the club medical staff. All injury data were collected by the team's physician using the Union of European Football Associations (UEFA) injury card. The UEFA injury card is an injury registration form that questions the name of the player, date of injury, date of return to full participation and injury specifications, namely the injured body part, the injury side and the type of injury. In this study, we were particularly interested in muscle strain injuries. For these muscle strains, the team's physician made the final diagnosis and this was supported with medical imaging (ultrasound or MRI). These muscle strain injuries were classified according to the grading system of O'Donoghue, with grade I representing no appreciable tissue tear, grade II indicating noticeable tissue damage and reduced strength, and grade III representing a complete tear.[16,17] Cramps or injuries involving direct contact were not included for further analyses. A player was considered fully rehabilitated when the team's physician allowed full participation in collective team training sessions or match play.

Assessment of SARS-CoV-2 infection

Assessment of SARS-CoV-2 infection was performed by means of a nasal swab-based PCR test. An independent contractor performed a mandatory test on each player at least 48 hours before each official game. If a player tested positive, a second test was performed within 48 hours to confirm the positive test result. Since the effect of early physical activity following SARS-CoV-2 infection was unclear, the team's physician urged the players not to engage in physical activity during their obligatory quarantine period. During quarantine, they were contacted regularly by the team's physician and were tested at least once a week using a PCR test. A negative PCR test had to be submitted in order to return to training. An overview of the infected players was documented by the team's physician, including the timing of the positive PCR test(s), the days absent from training and whether or not the infection caused the COVID-19 disease. In addition, the severity of symptoms (asymptomatic, mild, medium and severe) were registered, based on the classification made by the National Institutes of Health used as clinical guidelines, since patients with SARS-CoV-2 infection can experience a range of clinical manifestations ranging from an asymptomatic infection to severe illness. Asymptomatic Infection: Individuals who test positive for SARS-CoV-2 but who have no symptoms that are consistent with COVID-19. Mild Illness: Individuals who have any of the various signs and symptoms of COVID-19 (eg, fever, cough, sore throat, malaise, headache, muscle pain, nausea, vomiting, diarrhoea, loss of taste and smell) but who do not have shortness of breath, dyspnoea or abnormal chest imaging. Moderate illness: Individuals who show evidence of lower respiratory disease during clinical assessment or imaging and who have an oxygen saturation (SpO2) ≥94% on room air at sea level. And severe illness: Individuals who have SpO2 <94% on room air at sea level, a ratio of arterial partial pressure of oxygen to fraction of inspired oxygen <300 mm Hg, respiratory frequency >30 breaths/min or lung infiltrates >50%. All SARS-CoV-2 positive athletes got infected during the study period.

Statistical analyses

First, descriptive statistics were performed to present player characteristics, injury and SARS-CoV-2 infections for the three different teams. Second, a cross-tabulation was made to visualise the relationship between SARS-CoV-2 infections and muscle strain injury. Incident risk ratios or relative risks were calculated by dividing the incidence in one category by the incidence in the reference category. Third, different Cox proportional hazards regression analyses were used to investigate the association between SARS-CoV-2 infection status and development of muscle strain injuries. Possible confounding factors (like age, body mass index (BMI) and previous injury) were assessed. Since these variables might be associated with injury occurrence,[18 19] they were included in the model provided they were statistically significant ($p<0.05$). Because of the collinearity between SARS-CoV-2 infection status, days absent due to the infection and severity of the symptoms, only the analysis with the SARS-CoV-2 infection status variable was reported. Incidence rates of injury for the players according to SARS-CoV-2 infection status and other categorical confounders were calculated by dividing the number of injuries by the exposure time. The proportionality assumption was verified by visual inspection of plots of Schoenfeld residuals for each variable in the model. If the assumption holds, then the Schoenfeld residuals are not correlated with survival time. Variables for which the proportionality assumption failed were used as strata in a stratified Cox regression model. To determine the correct functional form of continuous covariates, Martingale residuals were used.[20] An alternative to the stratified cox proportional hazards model is the Frailty cox proportional hazards model, which accounts for variations in hazard rates within teams and between teams, by including a random effect term for teams (using coxme package). This Frailty cox proportional hazards model was also investigated. In addition, to account for biases induced by separation in the data resulting from the low frequencies in the response variable, a bias-reduced version of the cox proportional hazards (Firth' cox proportional hazards model)[21] model was also investigated using the coxphf package of the R software (R Foundation for Statistical Computing, Vienna, Austria). These three models (stratified cox proportional hazards model, Frailty cox proportional hazards and the Firth' cox proportional hazards model) were arbitrated using the Akaike's information criterion (AIC) and the final model was the model with the lowest AIC.

RESULTS

The final cohort of 84 male participants was divided between the three participating teams (team A=32, B=30 and C=22) and had a mean age (±SD) of 24.69±4.48 years. Of the 84 included participants, 22 were infected with SARS-CoV-2 during the follow-up period (June 2020–January 2021). Additionally, 61 developed an injury (73%) with a total of 84 injuries sustained. There were 18 muscle strains (consisting of grade I and II muscle injuries) registered over the three participating teams. Four players developed a muscle injury first and then became infected. These participants were included in the analysis (as infected with previous injury), but their muscle strain injury was not included as an outcome measure resulting in 14 muscle strains included in the analysis (figure 1). Participant demographics, injury overview and SARS-CoV-2 infections per team are summarised in table 1.

The results of the number of muscle strain injuries observed in athletes, without or after SARS-CoV-2 infection, are shown in table 2. Of these 14 players who developed muscle strain injury, 7 players (50%) had been previously infected with SARS-CoV-2. Incident rate for muscle strain injury was 0.3 per 1000 hours football participation. The risk ratio was 2.81 (95% CI 1.11 to 7.13), therefore, players with COVID-19 had almost three times greater risk of developing a muscle strain. Varying severity of symptoms was demonstrated in the players (ranging from asymptomatic to severe). These players all developed their muscle strain injury within the first month after rejoining the team (on average 15.71±11.74 days after the end of the quarantine period). In addition, players with a muscle strain injury showed a longer quarantine duration (14.57±6.50 days) compared with the SARS-CoV-2-infected players who did not develop a muscle strain injury (11.18±5.25 days).

The final model was the stratified cox proportional hazards model (AIC=53,9). AICs of the Frailty cox proportional hazards and the Firth' cox proportional hazards model were 78.3 and 70.3, respectively. BMI was included in the final model since it showed a significant association with muscle strain injury, and teams were accounted for as a stratification variable since teams were the only variable for which the proportional hazards assumption did not hold. The results of the stratified cox proportional hazards model analysis are presented in table 3. A significant association between SARS-CoV-2 infection and the development of muscle strain injuries was found ($p=0.037$). Specifically, the risk of developing a muscle strain was found to be five times higher (HR 5.1; 95% CI 1.1 to 23.1) following SARS-CoV-2 infection. Sensitivity analysis was performed with days absent due to SARS-CoV-2 infection and results were similar indicating that a longer quarantine duration resulted in

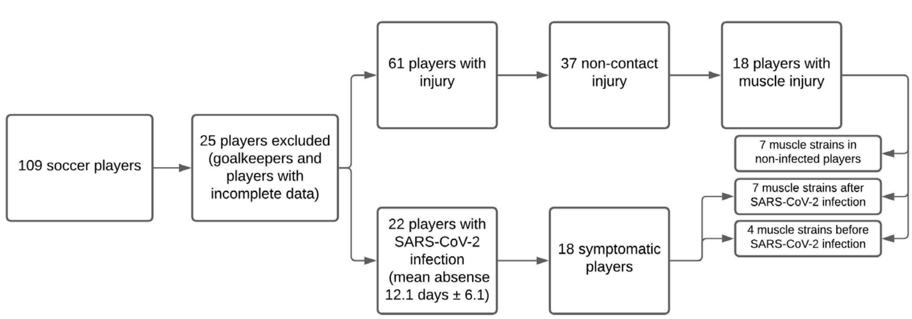

Figure 1 Flow chart to identify the group with injuries and the group with SARS-CoV-2 infection.

Table 1 Participant demographics, injury overview and SARS-CoV-2 infections per team

	Team A (n=32)	Team B (n=30)	Team C (n=22)	Total (n=84)
Participant characteristics				
	Mean±SD	**Mean±SD**	**Mean±SD**	**Mean±SD**
Age (years)	23.50±3.88	24.93±4.24	25.23±5.40	24.46±4.45
BMI (kg/m²)	23.30±1.31	23.95±1.88	23.49±1.46	23.57±1.57
Games/week (n)	1.70±0.55	1.64±0.56	1.23±0.43	1.52±0.48
Injury overview				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
Number of injured players (n)	22	22	17	61
Total number of injuries (n)	32	30	22	84
Non-contact injuries	15 (47)	14 (47)	8 (36)	37 (44)
Muscle strains	6 (19)	8 (27)	4 (18)	18 (21)
Time loss muscle strains (days, Median ±IQR) (Q1–Q3)	12.5±33.0 (7.0–38.5)	10.5±33.0 (3,0 -25,75)	7.5±21.0 (3.75–20.25)	10.5±37.0 (5.25–25.25)
SARS-CoV-2 infections				
	Frequency (%)	Frequency (%)	Frequency (%)	Frequency (%)
Number of infected players (n)	10	10	2	22
Symptoms of COVID-19 disease				
Asymptomatic	2 (20)	2 (20)	0 (0)	4 (18)
Mild	1 (10)	5 (50)	1 (50)	7 (32)
Moderate	5 (50)	3 (30)	1 (50)	9 (41)
Sever	2 (20)	–	–	2 (9)
	Median ±IQR (Q1–Q3)	Median ±IQR (Q1–Q3)	Median ±IQR (Q1–Q3)	Median ±IQR (Q1–Q3)
Quarantine duration (days)	9.0±12.0 (6.0–12.0)	15.0±25.0 (9.75–20.5)	15.00±0.0 (15.0–15.0)	11.0±25.0 (8.75–15.0)
Time between return to training and injury (days)	23.0±22.0 (17.5–28.5)	11.0±23.0 (3–23.5)	–	12.0±31.0 (3.0–26.0)

BMI, body mass index.

an increased hazard rate for the development of muscle strain injuries.

DISCUSSION

Our results found a five-time higher risk of developing muscle strain after a SARS-CoV-2 infection in elite male football players within the first month after sports resumption. Though caution is required when generalising these results due to the small sample size and low number of strains, these findings require further exploration. This is the first prospective study investigating the association between SARS-CoV-2 infection and (muscle) injury risk in elite football players and therefore comparing results with previous research is difficult. Nevertheless, an infection with a respiratory virus is not uncommon in the current climate of the elite sports world.[22]

Increased risk of muscle strain after SARS-CoV-2 infection

Physiological effects of quarantine

A first possible explanation for the significantly higher risk of a muscle strain after SARS-CoV-2 infection could be the mandatory quarantine period for the infected athletes. During this period, players were urged not to engage in physical activity and were therefore not exposed to the (continuously imposed) high intensity stimuli that they normally undergo during training and matches throughout a non-interrupted competition season. This might induce a certain level of (short-term) muscular detraining and can result in a partial or complete loss of training induced morphological and physiological adaptations.[4] de Boer *et al*[23] previously stated that in a period of suspension, an average strength loss in the lower limb of 1.06% a day was found over the first 2 weeks and a 0.68% strength loss a day the following 9 days.[23] The average absence of the infected players in this study was 12.14 days and, interestingly, the athletes who developed a muscle strain injury after COVID-19 diagnosis showed a slightly longer absence of 14±6.5 days. The clinical relevance of the quarantine duration was confirmed in the sensitivity analysis which showed that a longer quarantine duration resulted in an increased HR for the development of muscle strain injuries. So, according to the study of de Boer *et al*[23] a decrease in muscle strength

Table 2 Crosstab of players with a muscle strain injury and SARS-CoV-2 infection

		Muscle strain injury		
		No	Yes	Total
SARS-CoV-2 infection	No	55	7	62
	Yes	15	7	22
Total		70	14	84

Table 3 Multivariable analysis of the association between SARS-CoV-2 infections and muscle strain injury using Cox proportional hazards regression analysis (AIC=53.9)

Indicator	HR	95% CI	P value
BMI (kg/m^2)	2.0	1.2 to 3.1	0.004
SARS-CoV-2 infection	5.1	1.1 to 23.1	**0.037**

AIC, Akaike's information criterion; BMI, body mass index.

is already developed in the early phase of quarantine. The rate of muscle disuse-related strength loss may be even more expedited in elite football players since highly trained individuals with more prominent initial muscle mass revealed more accentuated muscle loss.[24] In addition to this, COVID-positive players immediately rejoined the team after their obligatory quarantine period and competed with players who were able to continue the training sessions (and were therefore exposed to identical volumes and intensities of athletic exposure). The athlete's internal pressure to regain their place in the team, the external pressure from the various stakeholders and the intensive game schedule could explain this rapid reintegration of the COVID-19-infected players after their quarantine period. It; therefore, seems possible that the SARS-CoV-2-infected players, regardless of their symptoms, resumed group training too early and that not enough consideration was given to a gradual build-up of the high training stimuli after the quarantine period. This assumption can be confirmed by a study of Seshadri *et al*[14] who examined 537 players from the 2019–2020 Bundesliga season and also found a proportionally higher number of injuries in these football players, with the athletes striving to play their first football match after the general COVID-19 lockdown in March 2020 particularly susceptible to injury.[14] Considering this, athletes may be more susceptible to injury because of the tissue-specific modification of the mechanical properties of muscle tissue due to the quarantine period,[4] although further research is necessary to investigate this.

Pathological effects of a SARS-CoV-2 infection

Although the direct effect of COVID-19 on injury risk is still unknown and should be studied further, another possible explanation might be the SARS-CoV-2 infection itself. Østergaard[10] found that a SARS-CoV-2 infection induced capillary flow disturbances, which can limit blood—tissue oxygen transport. These short-term capillary flow disturbances are shown to shorten bloods transit times through the remaining, patent capillaries, thereby limiting oxygen uptake.[10] This may exacerbate the previously described specific (short-term) muscular detraining, cardiovascular and metabolic detraining effects. These detraining effects include reduced blood volume, decline in capillary density and decreased oxidative capacity of the muscle.[25] Therefore, we can speculate that blood—tissue oxygen transport and thus muscle oxygenation responses during exercise will be compromised, altering energy metabolism in a more anaerobic direction with accumulation of metabolic by-products. This speculation suggests that both a SARS-CoV-2 infection (pathological) and short-term detraining effects (physiological), due to the quarantine period, could possibly induce earlier onset and higher rates of fatigue. In addition, these capillary disturbances are likely to reduce the endurance capacity of the elite players.[10 26] Watson *et al*[27] reported that a lower VO_2 max is an independent risk factor for the development of injuries in athletes. Although the precise pathway of how this lower aerobic power increases injury risk is still uncertain, it is probably moderated by the earlier onset of fatigue.[27] Fatigue is also associated with alterations in muscle recruitment patterns during physical activity and can cause altered biomechanics and force distribution across the musculoskeletal structures, increasing the risk of sustaining a muscle injury.[28] The accumulation of fatigue might be important in the development of muscle strain injuries since the accumulation of fatigue across training and competition periods is shown to be associated with elevated muscle injury risk, especially when abrupt increases in total training loads or intensities occur[29] (eg, return to training after quarantine). Moreover, reduced muscle oxygenation pattern may negatively affect recuperation during sport, for example, football, which display an intermittent profile (low-to-moderate intensity interspersed with high intensity activities).[30] Finally, previous research described that while the ability to maintain multiple sprint performance may be attributed to a multitude of factors, phosphocreatine availability and intracellular phosphate accumulation appear to be the most important determinants. The fact that both phosphocreatine availability and intracellular phosphate removal (via ADPphosphorylation) are oxygen-dependent processes suggests that a high level of aerobic fitness may convey an enhanced ability to resist fatigue.[30]

Clinical implications

Advocating a rehabilitation training schedule based on both aerobic endurance and maximal strength, with a gradual build-up of high intensity training stimuli after a SARS-CoV-2 infection is crucial to potentially prevent muscle strain injuries in (elite) athletes. Consequently, individual monitoring and training load management of each infected player to prevent fatigue could be necessary to potentially prevent muscle strain injuries. The importance of training load management in order to prevent sports injuries has been highlighted before, advocating for a moderate chronic training load and avoiding week-to-week changes,[31] and COVID-19 seems to emphasise this need. Elliott *et al*[32] provided a gradual return to play protocol under medical supervision after a SARS-CoV-2 infection, based on currently available expert opinions.[32] These guidelines include a six-stage plan with continuous monitoring of different parameters such as: resting heart rate, rate of perceived exertion, sleep, stress, fatigue, muscle soreness, injury-psychological readiness to return to sport and further assessment in case of prolonged illness (blood tests investigating inflammation markers, cardiac monitoring and respiratory function assessment), to enable safe competition resumption. According to these guidelines, the player must meet the following criteria before he/she can initiate the gradual return to play programme: (1) at least 10 days of relative rest must be completed, (2) the player must be symptom-free for minimally 7 days and (3) the (pharmacological) treatment has to be terminated. Full resumption of normal training progressions (in time and intensity) is allowed earliest at 17 days postdiagnosis of a SARS-CoV-2 infection. It is therefore possible that the participants in this study took part in full group training sessions too early, thereby neglecting the necessary gradual build-up until full participation, which is—according to the latest guidelines—only allowed at least 17 days after diagnosis. This possibly explains the higher incidence of muscle strain injuries after SARS-CoV-2 infections, however, further research is necessary to establish this.

Methodological considerations

Several limitations of this study should be mentioned. First, because of the small sample size, and the accompanying low events and wide confidence intervals, the most important limitation to address is sparse-data bias. The Cox proportional hazards model was used in this study to account for exposure, but caution is still needed when generalising these results due to the potential for sparse-data bias. We would strongly recommend future research to examine these findings in a study with a larger sample size and to investigate this association in different sports, sex and age levels. Second, the direct effect of SARS-CoV-2 infection on injury risk should also be investigated in future research since this study design did not allow us to make direct causal inference. In addition, the association found in this study should be interpreted taking the complex interdependent nature of many factors involved in sport injuries into account. As new evidence emerges, it is possible that the guidance for a safe return to play after SARS-CoV-2 infection should be further updated.

CONCLUSION

This is the first prospective study investigating the association between SARS-CoV-2 infection and (muscle) injury risk in elite male football players. The results of this study reported a five-time higher hazard rate to develop a muscle strain within the first month after sports resumption after SARS-CoV-2 infection. However, caution is needed when generalising these results because of the small sample size in this study and possible sparse data bias. Although this association should be examined further, it seems possible that short-term detraining effects due to quarantine, and potentially direct pathological effects of the SARS-CoV-2 infection, are associated with a higher risk of muscle strain injury and possibly related to lower physical readiness and higher rates of fatigue.

Key messages

What is already known on this topic

⇒ Because of the pathological effects of COVID-19 (predominantly on the cardiorespiratory system, but recently also shown to compromise peripheral muscle function as well), the question arises to what extent muscle strain injury is associated with SARS-CoV-2 infection.

What this study adds

⇒ The results of this study reported a five-time higher hazard to develop a muscle strain after SARS-CoV-2 infection in elite male football players within the first month after sports resumption. The athletes that developed a muscle strain injury after SARS-CoV-2 infection showed a longer quarantine duration compared with the SARS-CoV-2-infected players that did not develop a muscle strain injury.

How this study might affect research, practice or policy

⇒ The results of this study suggest that rehabilitation with a gradual build-up, based on both aerobic endurance and maximal strength, after SARS-CoV-2 infection is crucial to potentially prevent muscle strain injuries in elite male football players. Individual monitoring and training load management of each infected player should be considered to potentially prevent muscle strain injuries.

Acknowledgements The authors would like to acknowledge the Sports Medicine and Physical staff of KAA Gent, Royal Standard de Liège and Zulte Waregem for their commitment and contributions to this study.

Contributors Each of the authors has read and concurs with the content in the final manuscript. First author (EW) is responsible for the overall content as guarantor. We confirm that this manuscript has not been published elsewhere and is not under consideration for publication by any other online or print journal. All authors have made substantial contributions to all of the following: (1) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article or revising it critically for important intellectual content, (3) final approval of the version to be submitted.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Not applicable.

Ethics approval All participating players provided informed consent and this study was approved by the Ethics Committee of the Ghent University (number of approval: B670201940603).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available on reasonable request. Data are available on reasonable request. Requests for data sharing from appropriate researchers and entities will be considered on a case-by-case basis. Interested parties should contact EW (evi.wezenbeek@ugent.be).

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