

Effects of the Corona Pandemic on Competitive Sports – an Online Survey Amongst 2981 German and Austrian Elite Athletes

Auswirkungen der Corona-Pandemie auf den Leistungssport – eine Online-Umfrage unter 2981 deutschen und österreichischen Spitzensportlern

Summary

- ▶ **Background:** The impact of the corona pandemic on competitive sports has not yet been studied in a larger group of athletes.
- ▶ **Methods:** Using an online questionnaire, junior and adult elite athletes from Germany and Austria were asked about their infection status, potential symptoms of COVID-19, and the impact of the pandemic on their athletic activity.
- ▶ **Results:** Between April 21, 2020 and February 16, 2021, a total of 2981 questionnaires were recorded (50.3% female, 25.7% professional athletes, 37.9% national team members). 78 athletes (2.6%) reported a positive PCR test result for SARS-CoV-2. In addition, 67 (2.3%) athletes reported that they had experienced the disease but were self-diagnosed. In 19 athletes (0.6%), infection was suspected by a physician but without testing. 841 (28.2%) athletes stated that they were in quarantine at least once. At least one symptom that might be associated with COVID-19 was observed in 38.7% of all athletes. Cardiac symptoms were reported significantly more often in PCR-positive athletes than in the group of athletes without confirmed infection or no infection. 15 athletes (0.5%) were admitted to hospital due to COVID-19, 8 of them were hospitalized for more than 1 week.
- ▶ **Conclusion:** The corona pandemic has a massive impact on competitive sports. In addition to indirect consequences due to quarantine measures or cancellation of competitions, infections with SARS-CoV-2 occurred in a significant proportion of athletes. Severe courses with hospitalization were also recorded among competitive athletes.

KEY WORDS:

SARS-CoV-2, COVID-19, Infection, Questionnaire, Competitive Sports

Zusammenfassung

- ▶ **Hintergrund:** Die Auswirkungen der Corona-Pandemie auf den Leistungssport wurden bisher noch nicht an einer größeren Gruppe von Sportlern untersucht.
- ▶ **Methoden:** Mittels eines Online-Fragebogens wurden jugendliche und erwachsene Spitzensportler aus Deutschland und Österreich zu ihrem Infektionsstatus, möglichen Symptomen von Covid-19 und den Auswirkungen der Pandemie auf ihre sportlichen Aktivitäten befragt.
- ▶ **Ergebnisse:** Zwischen dem 21. April 2020 und dem 16. Februar 2021 wurden insgesamt 2981 Fragebögen erfasst (50,3% weiblich, 25,7% Leistungssportler, 37,9% Nationalmannschaftsmitglieder). 78 Sportler (2,6%) gaben an, ein positives PCR-Testergebnis für SARS-CoV-2 zu haben. Darüber hinaus gaben 67 (2,3%) Athleten an, dass sie bei sich selbst die Krankheit diagnostiziert hätten. Bei 19 Sportlern (0,6%) wurde die Infektion von einem Arzt vermutet, aber nicht getestet. 841 (28,2%) Athleten gaben an, dass sie mindestens einmal in Quarantäne waren. Mindestens ein Symptom, das mit COVID-19 in Verbindung gebracht werden könnte, wurde bei 38,7% aller Sportler beobachtet. Kardiale Symptome wurden bei PCR-positiven Athleten signifikant häufiger angegeben als in der Gruppe der Athleten ohne bestätigte Infektion oder ohne Infektion. 15 Athleten (0,5%) wurden aufgrund von COVID-19 in ein Krankenhaus eingeliefert, 8 von ihnen waren länger als 1 Woche hospitalisiert.
- ▶ **Schlussfolgerung:** Die Corona-Pandemie hat massive Auswirkungen auf den Leistungssport. Neben indirekten Folgen durch Quarantänemaßnahmen oder Absagen von Wettkämpfen traten Infektionen mit SARS-CoV-2 bei einem erheblichen Teil der Sportler auf. Schwere Verläufe mit Krankenhausaufenthalt wurden auch bei Leistungssportlern verzeichnet.

SCHLÜSSELWÖRTER:

SARS-CoV-2, COVID-19, Infektion, Fragebogen, Leistungssport

Introduction

The corona pandemic has still a massive impact on social and economic life around the world. The world of sports also has to deal with the consequences of the spread of the virus or the measures taken to contain the infection. As is well known, major events such as the Olympic Games in Tokyo 2020, the European Football Championship or the Tour de France have been postponed and especially in the first and second waves, e. g. soccer or handball matches had to be played either as ghost matches or in front of

a reduced number of spectators under strict hygienic regulations. On the other hand, there are only individual reports available on the consequences for athletes on an individual level, especially for competitive and top athletes during the first year of the pandemic. Additionally, cardiac involvement of COVID-19 has already been discussed at the beginning of the pandemic (10). However, initially most published data referred to persons with severe disease progression. At the beginning of the pandemic >

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1. UNIVERSITY HOSPITAL TÜBINGEN, Department of Internal Medicine V, Sports Medicine, Tübingen, Germany
2. TIROL KLINIKEN GMBH INNSBRUCK AND PRIVATE UNIVERSITY UMIT TIROL, Institute of Sports Medicine, Alpine Medicine and Health Tourism, Hall, Austria
3. PARACELSUS MEDICAL UNIVERSITY SALZBURG, University Institute of Sports Medicine, Prevention and Rehabilitation, Salzburg, Austria
4. UNIVERSITY VIENNA, Department of Sports and Exercise Physiology, Institute for Sports Science, Vienna, Austria



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CORRESPONDING ADDRESS:

Christof Burgstahler, MD
Department of Internal Medicine V,
Sports Medicine, Eberhard Karls University,
Hoppe-Seyler-Strasse 6
72076 Tübingen, Germany
✉: christof.burgstahler@med.uni-tuebingen.de

Table 1

Athlete's characteristic.

	NUMBER	PERCENT
Female/male	1500/1481	50.3/49.7
NATIONALITY		
German	2204	73.9
Austrian	720	24.2
Others	57	1.9
SQUAD MEMBERSHIP		
National	1360	45.6
Regional	1179	39.6
No squad	442	14.8
National League	929	31.2
National Team Members	1129	37.9
Professional Athletes	767	25.7
AGE (YEARS)		
Under 18	1448	48.6
18-30	1236	41.5
30 +	297	10.0
SPORT		
Endurance	742	24.9
Strength/Technique	874	29.2
Game Sports	810	27.2
TRAINING HOURS PER WEEK		
Up to 5	212	7.1
5 to 10	1794	32.7
More than 10	974	60.2

most data were derived from highly symptomatic and/or hospitalized patients. Data from asymptomatic patients or patients with mild infection are available now, but data derived from athletes are still limited and, in some cases, contradictory (9). However, the question of cardiac involvement may be very important, especially for athletes, as it is likely to increase the risk of sudden cardiac death during exercise.

The aim of this study was to determine the effects in connection with the pandemic in elite athletes and to investigate whether athletes - regardless of whether an infection had been confirmed or not - have experienced symptoms of a possible cardiac involvement in the first year of the corona pandemic.

For this purpose, a web-based questionnaire was designed, which was distributed to young as well as adult top athletes via regional and national sports associations.

Methods

A link to an online questionnaire consisting of a total of 10 close ended questions in addition to basic data (age group, gender, sport or sport classification, training scope, training experience and state of residence, squad membership or level of sport practice) was sent to young as well as adult top athletes via email with the invitation to participate. The link was sent via the responsible national and regional sports federations. In order to ensure the widest possible distribution, the four largest sports associations in Germany were selected (German Football Association, German Handball Federation, German Athletics Association, German Gymnastics Federation). At regional level, the

distribution was initially carried out by the regional Sports Association of Baden-Württemberg, Germany. Start of the survey was April 21st 2020. In June 2020 the web-based questionnaire was distributed in Austria via the national Olympic committee and to other national sports federations. A second call for participation was made at the end of September 2020. Participants who completed the survey for the second time were recorded separately, but not included in the analysis. The study was approved by the local ethic committee (number 244/2020BO2) and for Austria at the ethics board (RCSEQ, number RCSEQ-AZ 2745/20) of the Private University UMIT Tirol and was performed in accordance with the Declaration of Helsinki

Participants were asked to answer the following questions in the context of the COVID-19 pandemic: Had there been an infection (confirmed or not) with SARS-CoV-2 since February 2020? What symptoms had occurred since February that could indicate a COVID-19 infection? Have there been any other symptoms, especially cardiac problems? How long did the symptoms last? Was there any hospital treatment necessary? How long was the training paused? Was the athlete in quarantine? Was training suspended? To what extent was the training affected by the pandemic or the containment measures? Are the athletes concerned about their health, career or financial situation?

Names of the participants or data by which conclusions could be drawn about the participating person were deliberately not requested. Therefore, the exact age was also not requested, as this would possibly indicate the identity in the case of non-core sports.

When filling out the questionnaire, the respondents were specifically asked whether they had filled it out for a second time. If this was answered in the positive, the data were collected but not included in the evaluation.

Statistical Analysis

Statistical analysis was performed with computer software (JMP version 16, SAS Institute, Cary, NC). Categorical data were given as absolute numbers and percentages. Differences between two or more than two groups were performed by Pearson's χ^2 -test. Odds ratios were calculated from contingency tables. A p value of less than 0.05 was regarded statistically significant. The comparison between the first and second query does not refer to the same persons, but to the collective from the first or second call to participate in the study.

Results

Between April 21st 2020 and February 16th 2021, a total of 2981 questionnaires could be recruited. 2144 questionnaires were collected until September 30th 2020, 837 between October 1st 2020 and February 16th 2021. The athletes' characteristics are set out in table 1. Mean training years were 16.2 ± 2.0 SE.

Number of Confirmed infections and Quarantine During the Inquiry Period

78 athletes, or 2.62%, reported having a positive PCR test result for SARS-CoV-2. In addition, 67 (2.25%) athletes reported that they had experienced the disease but were self-diagnosed (e.g. due to loss of smell, but without a positive test having been carried out or a doctor having been consulted). In 19 athletes (0.64%), infection was suspected by a physician but without testing. Of the remaining athletes, 444 (14.89%) reported that they had a negative test. A total of 841 athletes (28.2%) stated that they were in quarantine at least once during the query period.

In 81 people due to a positive test, 254 people (8.52%) due to contact with a positive person, 198 (6.64%) due to stay in a risk area. Self-initiated quarantine was performed by 308 athletes (10.33%). The percentage of athletes who were not in quarantine decreased from 78.2% during the first survey period to 64.5% during the second survey period ($p < 0.0001$).

Possible Symptoms of COVID-19 during Query Period

Symptoms that might be associated with COVID-19 were observed in a high percentage of athletes. 38.7% reported to have had at least one symptom possibly indicating an infection with SARS-CoV-2. The most prevalent symptoms were rhinitis, sore throat and cough (see table 2).

Athletes with PCR Confirmed COVID-19

From the 78 athletes with PCR confirmed COVID-19, 38 (48.7%) were older than 18 but younger than 30 years, 23 (29.4%) younger than 18 years and 17 (21.8%) older than 30 years. 44/78 (56.4%) were female athletes. Age had a significant influence on the likelihood of having had a positive test ($\text{Chi}^2 0.0001$), as did the type of sport practiced with most infections in endurance athletes ($\text{Chi}^2 0.0051$), whereas no influence of gender could be detected ($\text{Chi}^2 0.2756$). Athletes of Austrian nationality had indicated a positive test significantly more often than athletes of German nationality (42/720 vs. 35/2204 or 5.83% vs. 1.59%, $p > 0.0001$). Symptom duration differed by infection status ($\text{Chi}^2 < 0.0001$): While only about 1% had a history of a confirmed infection with SARS-CoV-2 at the first period of the survey, this increased to 6.5% at the second period of the survey. Further details and symptoms are given in table 3.

Cardiac Symptoms in Athletes with and without COVID-19

Cardiac symptoms were reported significantly more often in PCR positive athletes than in the group of athletes without confirmed infection or no infection (odds ratio 3.57 [2.48-5.13], palpitations $p = 0.0063$, dizziness $p = 0.0038$, tachycardia $p < 0.0001$, chest pain $p < 0.0001$, table 4). In terms of syncopes no difference could be observed.

Duration of Symptoms, Hospitalization and Training Interruption

Most athletes recovered from symptoms (cardiac or non-cardiac) within one week. However, 186 athletes were symptomatic for more than one week. Athletes with confirmed infection had significantly longer symptoms than athletes without confirmed infection (more than 7 days of symptoms 45.5% vs. 16.0%). Despite symptoms training was not interrupted by 516 athletes, whereas training interruption in the others was predominantly at least 6 days. 15 athletes (0.5%) were admitted to hospital due to COVID-19, 8 of them were hospitalized for more than 1 week.

Concerns due to the Pandemic and Impairment of Sports Activity

The percentage of athletes who were not concerned about the pandemic decreased from 31% (first survey period) to 14% (second survey period). Worries about their own health in particular increased significantly over the course of the study, table 6 shows the type of worries by survey period.

Training was considerably affected by the pandemic. 29.5% indicated in the first query period that they were strongly or very strongly (39.6%) impacted in their exercise. This percentage decreased to 24.9% and 15.7% percent respectively in the second query period. The reporting of concerns was significantly lower at the second query time point than at the first query time point ($p < 0.001$). Details are given in table 7.

Table 2

Possible symptoms of COVID-19.

(N=2981)	NUMBER	PERCENT
SYMPTOM		
Fever	225	7.5
Cough	528	17.7
Ageusia	112	3.8
Rhinitis	818	27.4
Sore throat	580	19.4
Dyspnea	64	2.1
Muscle soreness	225	7.5
No Symptoms	1828	61.3

Table 3

Characteristics of athletes with confirmed COVID-19. *= $\text{Chi}^2 0.0001$; #= $\text{Chi}^2 0.0051$.

PCR CONFIRMED COVID-19 (N=78)	NUMBER	PERCENT
Female/male	44/34	56.4/43.6
National League	28	35.9
National Team Members	30	38.4
Professional Athletes	24	30.7
AGE (YEARS)*		
Under 18	23	29.5
18-30	38	48.7
30+	17	21.8
SPORT#		
Endurance	31	39.7
Strength/Technique	17	21.8
Game Sports	23	29.5
SYMPTOMS		
Fever	35	44.8
Cough	38	48.7
Ageusia	51	65.4
Rhinitis	45	57.7
Sore throat	28	35.9
Dyspnea	12	15.3
Muscle soreness	25	32.1
No symptoms	12	15.4

Discussion

The results of the online survey show several findings. Firstly, the high willingness to fill out the questionnaire was surprising although of course we do not know how many people the questionnaire was actually sent to. A population of almost three thousand competitive and professional athletes is certainly unique in this context and indirectly shows the relevance of the topic for competitive sports.

Infection with SARS-CoV-2 in Elite Athletes

As might be expected, the proportion of confirmed infections with SARS-CoV-2 was initially very low. This can be exp- >

Table 4

Cardiac symptoms depending on COVID-19 status. *= $p < 0.001$ confirmed vs. others, #= $p < 0.01$ confirmed vs. others.

	CONFIRMED COVID (N=78)		OTHERS (N=2903)		TOTAL (N=2981)	
	n	%	n	%	n	%
Palpitations	4	5.1 [#]	25	0.9	29	1.0
Dizziness	11	14.1 [*]	157	5.4	168	5.6
Tachycardia	7	8.9 [#]	31	1.1	38	1.3
Syncopes	1	1.2	14	0.5	15	0.5
Chest pain	11	14.1 [*]	75	2.6	86	2.9

Table 5

Duration of cardiac and non cardiac symptoms and duration of training break.

DURATION	SYMPTOMS		INTERRUPTION OF TRAINING	
	N	% OF 2981	N	% OF 2981
1 to 2 days	351	11.8	190	6.4
3 to 5 days	359	12.0	167	5.6
6 to 7 days	143	4.8	107	17.3
More than 7 days	186	6.2	304	10.2

lained by the low testing capacity, especially at the beginning of the pandemic. Therefore, questions were also asked about suspected infections. These could be either physician-diagnosed or self-diagnosed. Diagnosis by a physician or self-diagnosis was based on the appearance of typical clinical symptoms, first and foremost a loss of smell (8). Thus, a total of about 5.5% of the participants assumed to have been infected.

However, there is probably a high number of unreported cases, because an infection can be asymptomatic (3, 6), with younger age being associated with a higher likelihood of an asymptomatic course (7). In our study, 15% of those with confirmed infection remained asymptomatic. The proportion of asymptomatic infected individuals varies depending on the population studied. For example, in a study of health professionals, the proportion of asymptomatic infections was reported to be 2.4% (6). In contrast, a model describing the dynamics of COVID-19 assumes 10% asymptomatic infections (1). Both figures are thus lower than the proportion we documented. There are several possible explanations for this:

First, among infected athletes, the proportion of athletes under 18 years of age was relatively high at nearly 30 percent, favoring an asymptomatic course. Second, it can be assumed that asymptotically infected athletes were discovered in the course of routine tests, as they were performed relatively early in competitive sports. Thus, the transferability of these findings to the general population is limited, respectively not possible.

Interestingly, a positive test was indicated more frequently in Austria than in Germany, which may have different reasons. Firstly, the questionnaire was made public later in Austria, so that there was a longer period of time between a potential infection and the completion of the questionnaire, which increases the probability of an infection. Of course, this also applies when considering the first and second query periods for the entire collective, which must be regarded as a limitation. On the other hand, PCR tests might have been available earlier in Austria (in competitive sports) than in Germany.

It remains to be noted that potential symptoms of infection with SARS-CoV-2 were reported relatively frequently (38% of participants). However, symptom duration was significantly longer in the group with confirmed infection with SARS-CoV-2 than in the group without confirmed infection, which would suggest that part of the group without proven infection had only experienced common viral or bacterial infections during the query period. Only the loss of smell already would be considered in this context as actually pathognomonic for COVID-19. However, it has also been shown that it is symptoms such as fever (present in 7.5% in our study), muscle pain (7.5%), and cough (17.7%) that increase the likelihood of being infected with SARS-CoV-2 (6). Thus, the determined incidence of approximately 5.5% in our sample should therefore only represent a lower limit of the actual contamination. On the other hand, it can be argued that especially in competitive athletes - at least in the professional field - testing was performed early in the course of the pandemic when symptoms occurred and thus the proportion of undetected infections could be reduced.

Cardiac Symptoms in Athletes with Confirmed COVID-19

Already in the early phase of the pandemic, there were reports that COVID-19 could also lead to cardiac symptoms or affections (5). This was initially observed mainly in hospitalized individuals. In the meantime, several studies have been conducted on smaller groups of athletes (2, 4), which, however, have come to very different conclusions. This is certainly also due to the fact that different examination methods were used in the studies. In addition, it is well known that symptoms and examination findings can vary over time following infection with SARS-CoV-2 (9). Unfortunately, the data we collected do not allow us to draw any conclusions about the time course of symptoms, as the questionnaire was deliberately designed to be simple in order to keep the response rate high. In any case, it remains to be noted that cardiac symptoms were reported more frequently in cases of confirmed infection than in the rest of the athletes.

Although the participating volunteers consisted of highly trained and obviously healthy competitive athletes, 15 persons had to be treated as inpatients due to the infection. This shows that despite a high level of fitness and a relatively young age, severe courses can occur. Thus, preventive measures such as hygiene concepts and vaccination, which was not yet widely available at the time of the survey, are also necessary in top-level sport.

Impact on Sporting Activity and Concerns of the Athletes

In addition to direct consequences due to infection, there was also a massive indirect impact on sporting activity. 28% of participants in the survey reported having been quarantined at least once. In addition to the (at least temporary) closure of sports facilities, this had a massive impact on training and athletic performance.

Table 6

Concerns of the participants during the first and the second query time.

CONCERNS	APRIL 2020 TO SEPTEMBER 2020		OCTOBER 2020 TO FEBRUARY 2021		P
	N=2144		N=837		
Health	454 (21%)		337 (40%)		<0.0001
Career	656 (31%)		303 (36%)		0.002
Sports in general	1053 (49%)		465 (56%)		0.017
Finances	263 (12%)		96 (11%)		0.573
No concerns	673 (31%)		117 (14%)		<0.0001

Table 7

Impairment of training during the first and the second query time.

IMPAIRMENT OF TRAINING	APRIL 2020 TO SEPTEMBER 2020 N=2144		OCTOBER 2020 TO FEBRUARY 2021 N=837	
	N	%	N	%
Not at all	116	5.4	60	7.2
Moderate	545	25.4	263	31.4
Strong	632	29.5	208	24.9
Very strong	848	39.6	131	15.7

Supplementary questions were asked about concerns of the athletes. Whereas in the first survey period 31% said they were not worried, this proportion fell to 14% in the course of the survey. There was a significant increase in the number of concerns about their own health. This could have been due to cases in the personal environment with a more complicated course of COVID-19, but this remains speculative. Interestingly, financial concerns were not at the forefront. This may be due to the fact that in the youth sector, livelihoods are not financed by sport or that professional athletes, who made up a high proportion of the participants, were able to build up a financial cushion in advance. In addition, many top-level athletes receive support from the public sector (e.g., the Federal Armed Forces), which continued during the pandemic.

The study has some limitations. For example, it is unclear how high the response rate to the questionnaire was, as the number of emails sent with the link to the survey is not known. Furthermore, the motivation to participate in the survey might be higher among infected or symptomatic persons than among non-infected persons. Ultimately, the data only refer to the first year of the pandemic, in which wild-type virus and the alpha variant were predominant and vaccinations were not available until the beginning of 2021. Therefore, the data cannot be transferred to other virus variants or vaccinated athletes. Another limitation is that no medical records are available to verify the information and the impact of possible confounders was not evaluated by multi-variate analysis.

Key Messages

- The pandemic with SARS-CoV-2 has a massive impact on elite sports.
- At least 5.5% of elite athletes (PCR-diagnosed, self-diagnosed or diagnosed by a physician without testing) suffered from COVID-19 between February 2020 and February 2021.
- Potential symptoms of infection with SARS-CoV-2 were reported in 38% of all participating athletes.
- Cardiac symptoms were reported more frequently by infected athletes than by the rest of the athletes surveyed.

- Severe courses with hospitalization are rare among elite athletes, but not excluded.

Conclusion

Our online survey confirmed a massive impact of the pandemic on sports. More than 28% of the participants in the survey had been quarantined at least once. While only about 1% were confirmed to be infected during the first period of the survey, this increased to 6.5% at the second time. 15% of athletes who were tested positive had no symptoms, which could indicate a high number of unreported cases, especially at the beginning of the pandemic, when comprehensive testing was not yet available. Additionally, a high proportion of potential symptoms of infection with SARS-CoV-2 were also found in the overall collective. Despite symptoms, not all athletes have taken a break from training.

Cardiac involvement of infection seems likely, even in top-level athletes. Thus, a higher proportion of cardiac symptoms were found in confirmed infection. Although participants were competitive athletes who typically have high fitness and good health, hospitalization was required in approximately 0.5% of cases.

During the course of the survey, a smaller impact on training was found. This is most likely due to the fact that special arrangements were made for top athletes. Irrespective of this, a high number of competitive athletes were concerned about their health and athletic career, and these concerns even increased in the course of the survey. ■

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Conflict of Interest

The authors have no conflict of interest.

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