The First Season After the COVID-19 Pandemic: Cardiorespiratory and Statistics' Performance in Czech Ice Hockey Players

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ABSTRACT

The study describes the cardiorespiratory and statistical performance of ice hockey players during the season of 2020 after the COVID-19 lockdown'. Eight elite Czech male players (4 non-COVID-19 and 4 COVID-19 groups) were evaluated before and after the competition season. Players performed a cardiorespiratory exercise test and the maximal oxygen consumption, ventilatory threshold, respiratory compensation point, maximal heart rate and test time were measured. The number of matches, goals and plus/minus statistics were retained. No significant differences between groups before and after the season for all cardiorespiratory responses were found, and the no-COVID-19 group played more games. The conclusion highlights that the cardiorespiratory performance place all players (with and without COVID-19 history) in similar conditions to be prepared for the next season. Due to a wide variation among players' statistics, based on plus/minus parameters, it cannot be established that the 2020 season impaired the players' statistics.

Keywords: ice hockey; Covid-19; physical performance; plus/minus statistics

INTRODUCTION

The first season of 2020/2021 after a lockdown due to the SARS-CoV-2 (COVID-19) pandemic was a unique condition for team sports, in which new restrictions and changes in the rules were implemented to minimize the negative impact on player welfare and to avoid in-team transmission (Herrero-Gonzalez et al., 2020). Nevertheless, the preventive measures were not enough to reduce the players' infection. A higher in-game team-to-team transmission of COVID-19 was demonstrated in the Finnish ice hockey league. During a 16-day follow-up period, one asymptomatic carrier in a team led to 49 infections in five teams (Kuitunen et al., 2021).

A few studies have reported the consequence of COVID-19 infection in team players' cardiorespiratory capacity. Fikenzer et al. (2021) described that elite handball players with a history of COVID-19 infection presented a significant reduction in cardiopulmonary performance compared to uninfected teammates (Fikenzer et al., 2021). Parpa and Michaelides (2022) reported that soccer players infected with the COVID-19 virus presented a significant decrease in maximal oxygen consumption (VO_{2max}) after 60 days of recovery. Besides the impairment of the cardiorespiratory performance, the players' unavailability to play could also affect their performance during the season (Parpa & Michaelides, 2022).

In the ice hockey discipline, which presents a long competition season, information about the effect of COVID-19 infection on players during the 2020 competitive season is still unclear. Such information may help to understand what occurred in the season and what could be incorporated in similar situations in case of a new lockdown or transmissive virus. The aim of the study was to describe the first season after lockdown 2020/2021 in a Czech ice hockey team, reporting the players' cardiorespiratory responses and their statistics during the season. For this purpose, a comparison between players infected by the COVID-19 virus against those not infected was performed. Team statistic was compared to the previous season (2019-2020 and 2018-2019). According to the literature, we hypothesize that players diagnosed with COVID-19 positive will present lower values of cardiorespiratory parameters and a decrease in game statistics compared to those teammates not infected.

METHODS

Participants

The ice hockey team investigated was composed of 43 players registered in the 2020-2021 Extraliga, in which 26 of them attended the laboratory to perform a cardiorespiratory test. For the purpose of the study, data from 8 ice hockey players (age 27 ± 5.16 years; body mass 88.2 ± 9.03; height 183 ± 7.46 cm), measured before and after the season, was retained. The inclusion criteria were to visit the laboratory before and after the season. Only 8 players have data in two moments. Most of players was not able to do second measurement (transferred or did not able to play in A team). Goalkeepers were excluded from the study. After the season, the players were separated into a group with No-COVID-19 (n=4) for those who reported no infection during the season and a group COVID-19 (n=4) for those who reported being infected during the season. Players signed informed consent at the beginning of their clinical evaluation in both conditions, pre- and post-competition, stating that their personal data could be used for research purposes (Approval number: EKV-2021-062).

Design

A retrospective design was used to describe the cardiorespiratory performance of ice hockey players assessed in laboratory conditions, and to describe the statistic during the season. The team was first evaluated in the laboratory post-COVID-19 lockdown to verify the players' functionality to engage in the competition season (August 2020) and measured again after the season (April 2021)

as a preparation for the next season (2021-2022). In the first measurement, all players reported negative for COVDI-19 infection and were evaluated by a cardiorespiratory exercise test (CPET) performed on a treadmill. After the season, they performed the second CPET on a cycle ergometer. Four of 8 players reported positive for COVID-19 infection during some point in season. (Figure 1). The players' statistics during the season was taken from the team website and compared with the previous season (2019-2020 and 2018-2019).
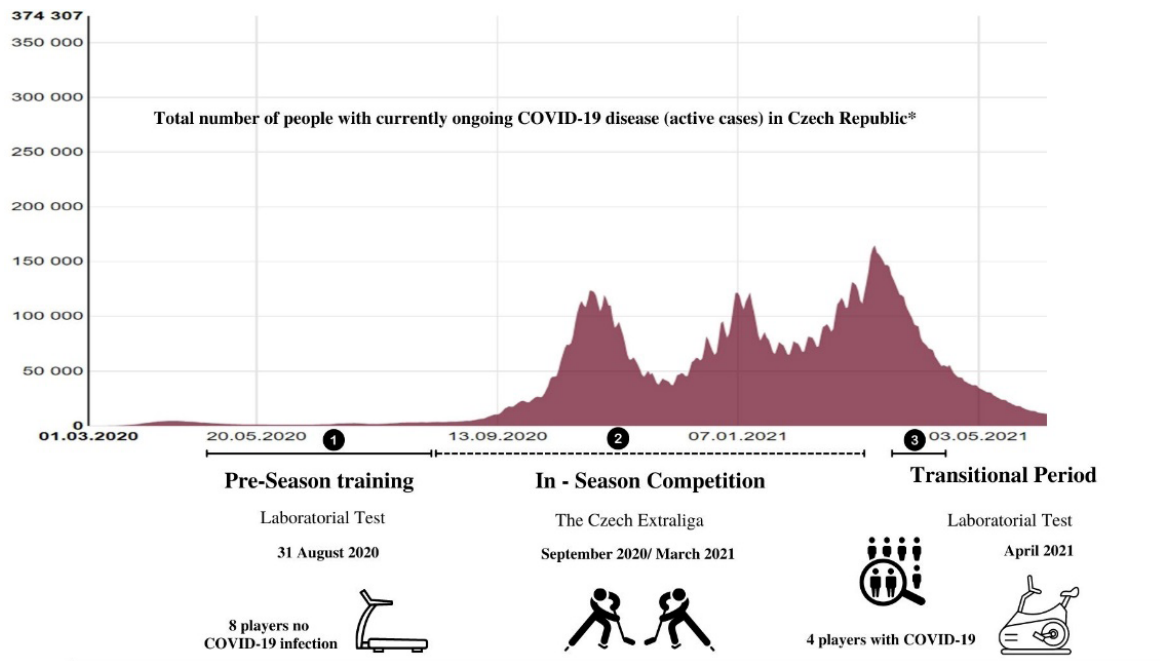

Figure 1. Study design.

1-Pre-season training period from May to the end of August of 2020. Laboratory test on 31st August on the treadmill, with no COVID-19 infection and lower rates of infection in the Czech Republic. 2- Competition season from September 2020 to March 2021 with a significant increase in COVID-19 infection in the Czech Republic (the second way). 3- Transitional period in April 2021. Laboratory test on the cycle ergometer.
*Source: (COVID-19, Onemocnění Aktuálně MZČR, 2022).

Ice hockey Extraliga 2020-2021
The ice hockey Extraliga in 2020-2021 had the participation of 14 teams, from 14 different cities around the Czech Republic. It was a total of 52 games for each team during the main season, in which the teams travelled at least once a week to compete in an away venue. After the main season, the team played 9 more games in the play-off and dropped out in the quarterfinals, finishing in 9th place (*Hokej.cz*, 2022).

Cardiorespiratory parameters
Before each cardiorespiratory exercise test (CPET), all players completed an anamnesis and meet the conditions about their actual health, genetic predisposition to cardiovascular diseases, non-acute diseases, infections or inflammations, or traumas influencing physical performance. The CPET was performed on a treadmill in the first evaluation and on a cycle ergometer in the second.

CPET protocol in the treadmill was designed as an incremental test on the Lode Katana ergometer (Netherlands) to volitional exhaustion. The test started with a speed of 8 km/h and 1 % of inclination each 2:30min. An increase in the speed of 0.5 km/h was implemented every minute and an increase of 1% on inclination was implemented every two minutes. CPET protocol in the cycle ergometer was designed as a ramp test on the Lode Excalibur ergometer (Netherlands) to volitional exhaustion. The test started 30 seconds without any resistance for a warm-up, following resistance of 1 Watt per kilogram of body weight (W/kg), increasing 0.33 W/kg each minute. Players were in-structed to keep constant rotations per minute (rpm) pedalling as long as possible (70-80 rpm).

In both tests, the oxygen consumption (VO_2) was measured during the test using breath-by-breath gas exchange analysis (Cortex METALYZER® 3B, Biophysik, Leipzig, Germany). After the test, data were processed using MetaSoft®Studio software to de-rive the following variables: maximal oxygen consumption (VO_{2max}), oxygen uptake at ventilatory threshold (VO_{2vt}); respiratory compensation point (VO_{2rc}); maximal heart rate (HR_{max}). Also, the time in the cycling and treadmill test was retained.

Anthropometric measurements

The body height was recorded using a wall stadiometer SECA 285 (Germany). Body composition was measured with direct analysis of segmental multi-frequential bioelectric impedance (SMF-BIA method) using the instrument InBody 770 (Cerritos, California, USA).

Players' statistics

Information about the players' statistics was taken after the end of the 2020-2021 season based on the season statistics displayed on the team website: www.hc-kometa.cz. Information about the number of matches in which the players started, goals and plus/minus statistics were collected. It was considered the players' statistics only on the seasons that he played in the selected team.

Statistical analysis

Values are presented in median with minimum and maximum. Comparison between groups was performed by non-paired t-test. Data were analysed using statistical software JAMOVI 2.2.5. and statistical significance was set at p≤ 0.05.

RESULTS

Cardiorespiratory responses and body mass are displayed in Table 1 (median, minimum and maximum). No significant differences between Non-COVID-19 and COVID-19 groups both before and after the competition season for all cardiorespiratory responses (e.g. oxygen uptake at the ventilatory threshold, respiratory compensation point, maximal heart rate and time in the test) nor for body mass.

Table 1. Cardiorespiratory responses and body mass pre and post-2020/2021 season

Pre-Season	Non-COVID-19 (n=4)	COVID-19 (n=4)	p
CPET (treadmill)			
VO_{2vt} (ml/kg/min)	32.5 (27.8 – 36)	34.3 (30 – 39.9)	0.402
$VO2_{rc}$ (ml/kg/min)	45 (38 – 47.7)	43.8 (38.4 – 50.3)	0.967
RT (min)	12 (10.3 – 14.3)	13.7 (10.1 – 14.3)	0.115
HR_{max} (bpm)	185 (185 – 186)	193 (185 – 206)	0.563
Body mass (kg)	90.7± 3.88	83.1± 9.03	0.173
Post-Season			
CEPT (bike)			
VO_{2vt} (ml/kg/min)	29.3 (25.9 – 31.4)	29.4 (25.1 – 31.2)	0.920
$VO2_{rc}$ (ml/kg/min)	37.3 (35.9 – 39)	40.3 (34 – 46.5)	0.322
CT (min)	10.1 (9.4 – 13.4)	10.6 (10.1 – 12.3)	0.105
HR_{max} (bpm)	186 (184 – 189)	194 (185 – 206)	0.871
Body mass (kg)	92.0 ±2.55	81.2 ±10.92	0.102

*CPET= cardiorespiratory exercise test; VO_{2vt}= oxygen uptake at ventilatory threshold; $VO2_{rc}$=respiratory compensation point; CT= cycling time; RT= running time; HR_{max}= maximal heart rate. cardiorespiratory exercise test (CPET).

Table 2 presents the description of each player about their performance in the competitive season of 2020–2021, and previous seasons 2019–2020 and 2018–2019. As expected, the No-COVID-19 group played more games during the 2020–2021 season compared to the COVID-19 group (143 *versus* 118 games). Players presented a wide variation among them throughout the season, based on plus/minus parameters, therefore it cannot be established that the 2020-2021 season presented a decrease in the players' performance, especially in the COVID-19 group.

Table 2. Ice hockey player statistics for the 2020-2021, 2019-2020 and 2018-2019 seasons.

	Position	GP			Goals			Plus/Minus		
		2020–2021	2019–2020	2018–2019	2020–2021	2019–2020	2018-2019	2020–2021	2019–2020	2018–2019
No COVID-19										
Athlete 1	Forward	52	51	52	15	29	22	5	1	15
Athlete 2	Forward	19	23	-	0	1		-5	3	-
Athlete 3	Defender	51	51	52	0	1	3	6	-1	4
Athlete 4	Defender	21	48	50	1	0	2	-2	0	-7
Total		143						4		
COVID-19										
Athlete 5	Forward	49	38	52	12	12	17	10	-3	18
Athlete 6	Forward	14	15	13	1	1	0	-1	-5	-3
Athlete 7	Forward	20	-	-	3	-	-	-3	-	-
Athlete 8	Forward	35	49	16	4	1	1	0	-2	1
Total		118						6		

* GP= games played.

DISCUSSION

The present study focused on describing the cardiorespiratory and statistics performance in an ice hockey team during the Extraliga 2020-2021 in the Czech Republic, comparing players with and without COVID-19 diagnosis. It was found that the cardiorespiratory parameters did not differ between players who were infected with the COVID-19 virus during the competitive season compared to those who were not infected. In addition, no consensus about impairment on players' statistics (based on plus/minus results) was observed in the 2020-2021 season compared to the previous season 2019–2020 and 2018–2019.

In terms of cardiorespiratory parameters, it has been described that the COVID-19 infection caused functional impairment of cardiopulmonary performance (Fikenzer et al., 2021) reducing players' maximal respiratory oxygen uptake (VO_{2max}) (Fikenzer et al., 2021; Parpa & Michaelides, 2022), maximal respiratory minute volume (VE) (Fikenzer et al., 2021), respiratory compensation point (VO_{2RC}) (Parpa & Michaelides, 2022), and increase the maximal heart rate during CPET. Interestingly, the same parameters assessed in the present study by the CPET test demonstrate to be similar among the ice hockey players. These results place all players (with and without COVID-19 history) in similar conditions to be prepared for the next season. Due to no previous study, it was not possible to verify if similar outcomes are also presented in ice hockey players from different teams.

Considering the unavailability to play and the restriction on training together as a team, it was hypothesized that players that were infected by COVID-19 during the competitive season had a decrease in their statistics, however, no impairment on players' plus/minus statistics was consisted in the 2020-2021 season compared with the previous one nor the players with COVID-19 infection during the season compromised their statistics compared to their counterparts. The No-COVID-19 group played more games compared to COVID-19 players, but with no influence on game statistics. The plus/minus statistics are calculated based on how many goals the team scored (plus) and how many goals the team conceded (minus) while the player is on ice (Lundgren et al., 2016), however, besides this index being widely used and registered in the National Hockey League (www. nhl.com), player's performance in the ice involves a complex interaction of physical performance, contact skills and decision-making ability. In the soccer league, the game performance comparison of COVID-19 and no-COVID-19 season was also controversial. No difference in running performance during the game comparing the season disrupted by the pandemic (2019-2020) to a control season (2018-2019) was found in LaLiga (Brito de Souza et al., 2021). On the contrary, in another soccer league, a match analysis reported that after the lockdown, the games presented a significant decrease in goal attempts, distance covered and an increase in fouls committed (Santana et al., 2021). Furthermore, despite a set of recommendations for home training, the return to training and competition after lockdown and COVID-19 infection for athletes (Bisciotti et al., 2020; Phelan et al., 2020; Stokes et al., 2020), performance alterations due to the lockdown were observed in previous review studies (Córdova-Martínez et al., 2022; Paludo et al., 2022).

To the best of our knowledge, this is the first study to describe the cardiorespiratory and statistics performance of ice hockey players during the first competitive season of 2020–2021, the

first season after the COVID-19 lockdown. However, some limitations should be highlighted. The reduced number of players assessed, together with no information about the period of the season in which the player had COVID-19 and the severity of the is the major limitation. The results should be carefully interpreted, and extrapolation could be made after further investigations.

CONCLUSION

The results suggest that despite the COVID-19 infection during the 2020-2021 competitive season, no significant differences in cardiorespiratory parameters were found, demonstrating that ice hockey players with COVID-19 history performed similarly in the cardiorespiratory test to those who were not diagnosed with it. The statistic during 2020-2021 was not impaired for the most of players, compared to the previous season, even with players with no-covid participating in more games. Monitoring the cardiorespiratory parameters in those players infected is recommended, due to the uncertain consequence of the virus on cardiorespiratory function in long term. Also, further investigation can add the use of GPS to evaluate the effect of COVID-19 infection on physical game performance. The literature regarding ice hockey on the topic of the effect of COVID-19 infection still is scarce and the present study comes to add a piece of information about it.

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