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# The incidence and transmission of SARS-CoV-2 infection in South African professional rugby players - AWARE II

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ABSTRACT

*Objectives:* To describe the incidence and transmission of SARS-CoV-2 infections in South African professional rugby union players in different phases of return-to-competition during a pandemic.
*Design:* Prospective cohort study.
*Methods:* Players reported their history of SARS-CoV-2 infection before/during a national competition, using an online questionnaire (physician verified). Three periods of return to training/competition after a nation-wide complete lockdown during a pandemic were studied: 1) non-contact training, 2) contact training, 3) competition. The total period was 184 days (20/07/2020–20/01/2021) including 45 matches. Outcomes were: 1) incidence of SARS-CoV-2 infection (I: per 1000 player days; 95%CI) in each period (calculated using a Poisson distribution), 2) player symptoms, 3) median days to return-to-training following SARS-CoV-2 infection, 4) method of transmission, and 5) percentage matches cancelled due to SARS-CoV-2 infections.
*Results:* 185 players had 42 physician verified positive SARS-CoV-2 infections ($I = 1.23$; 95%CI: 0.86–1.61). Incidences during the three periods were: non-contact training = 0, contact training ($I = 1.04$; 0.36–1.71; mostly forwards), and competition ($I = 1.54$; 1.00–2.10). 83 % of the infected players were symptomatic and 52 % of the 42 positive players had systemic symptoms. Median return-to-training was 14 days. 22 (52 %) SARS-CoV-2 infections were rugby-related: 13 off-field (31 %), 9 on-field (21 %). 11 % of matches were cancelled due to SARS-CoV-2 infections.
*Conclusions:* As contact in rugby was introduced back into the game following lockdowns there was an increasing incidence of SARS-CoV-2 infection. On-field rugby activities were responsible for 21 % of SARS-CoV-2 infections and 11 % of matches had to be cancelled, indicating the need for risk mitigation strategies.


## Practical implications

- In a pandemic of this nature practitioners would have needed to prepare for 1 in 5 rugby players contracting SARS-CoV-2
- The contact nature of rugby union represents a higher risk for transmission of the SARS-CoV-2 virus, therefore risk mitigation strategies in contact sports need to be reviewed and adjusted
- During on-field activities, forwards were most commonly infected (most likely due to the scrum situation), and therefore there is a need for further investigation for risk mitigation strategies for these players and their activities.

## 1. Introduction

The COVID-19 pandemic, caused by SARS-CoV-2 virus infection,[1] resulted in an initial ceasing of all sport worldwide. Complete lockdowns were imposed in many countries, including South Africa. Sports federations developed varying regulations and introduced gradual return to some form of competition. There are few data on the incidence and transmission of SARS-CoV-2 in different sporting populations, including team sports, as they returned to full competition. A study in football players in Qatar showed that in only 1 out of 36 SARS-CoV-2 positive players during a tournament, the transmission could be traced back to a football-related situation (support staff transmission).[2] A Finnish ice hockey study on the other hand, showed team-to-team transmission with one player infecting 22 other teammates, as well as 27 other players from two opposing teams.[3] These studies to date have been in

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small samples, were conducted over relatively short periods, and data capturing was in some cases performed using media reports.[4]

Rugby Union (hereafter referred to as rugby) is a particularly difficult sport to mitigate the risk of SARS-CoV-2 transmission, owing to the collision and physical contact nature of the sport, particularly during tackles, lineouts, loose ruck / mauls and scrum phases of play.[5,6] In these phases, both physical contact and high rates of ventilation increase the risk of aerosol transmission.[7,8] The only rugby study so far published was on rugby league players. In this study, only 8 players tested positive for SARS-CoV-2 infection with no established cases of rugby-related transmission[9] but importantly, scrums were removed.

The main aim of this study is to describe the incidence of SARS-CoV-2 infections in a cohort of professional rugby players during different phases of return-to-competition during a pandemic. We also compare the pattern of infections in the rugby player cohort to that of the general population during the same study period. Secondary aims are to determine possible mechanisms of SARS-CoV-2 transmission during rugby, and report symptoms and days to return-to-training in SARS-CoV-2 infected players.

## 2. Methods

This was a prospective cohort study involving professional rugby players from teams preparing and then competing in a national tournament. All seven teams (approximately 30–40 players per team) participating in the Super Rugby Unlocked and the Carling Currie Cup rugby competitions were invited to participate. Players gave electronic consent for their data to be used for research purposes. The study has ethical clearance from the Faculty of Health Sciences (REC: 409/2020).

Before the study began (prior to the non-contact phase), South Africa went through various phases of lockdown during the COVID-19 pandemic (complete lockdown where no out-of-household movement was allowed; partial lockdown with a 10 km radius where people were allowed to move for exercise purposes only etc.), and when non-contact training began, no inter-provincial travel was allowed, and households were not permitted to mix. During the study period, South Africa went through two distinct "waves" of SARS-CoV-2 infection in the general population. We wanted to compare the pattern of infection rates in rugby players to that of infection rates in the general population at the same time points (South Africa, new cases per 100,000 inhabitants, using data from the National Institute for Communicable Disease [NICD]). Population data were obtained from the NICD and a national estimate per week calculated using the daily population data downloaded (estimated based on 59.31 million people in South Africa).[10] The NICD was also consulted regarding the SARS-CoV-2 variant at the time.

There were three phases during the ~6-month study period:

- non-contact training: 20 July 2020–17 August 2020, gym and non-contact field training allowed;
- contact training: 17 August 2020–3 October 2020, team field contact training (e.g. tackling, scrums);
- competition: 3 October 2020–20 January 2021, full contact competition between teams (weekly matches);

The competition and public health regulations for the return to rugby required every player and support staff to be tested for SARS-CoV-2 from the moment the team began training. Nasopharyngeal samples were obtained from all participants on a weekly basis and polymerase chain reaction (PCR) testing for SARS-CoV-2 was done. Further details of the testing protocols can be found in the Supplementary File.

Every player was asked to complete the AWARE survey[11] at two different time-periods (November 2020 – the beginning of Super Rugby Unlocked, and mid-January 2021– the end of Carling Currie Cup) regarding their respiratory health (the first questionnaire concerned their health in the past 6 months [June 2020 – November 2020] and the second was for the last 3 months since the previous questionnaire [November 2020 – January 2021]). Players completed the survey online using the Research Electronic Data Capture (REDCap) platform.[12,13] Further details regarding the questionnaire have been detailed in a previous study.[11] The questionnaire included questions about the player's demographics, co-morbidities, and respiratory health (whether they had been diagnosed with SARS-CoV-2 or were healthy). The SARS-CoV-2 positive players were asked to answer further questions regarding method of diagnosis, and the date of onset, type, duration and severity of symptoms. The players also reported the time to return-to-training ("*How many days were there between the start of your symptoms and the return to your first training session*?"). All SARS-CoV-2 positive records were physician verified and had positive PCR tests, as well as the date of diagnosis (through telephone or email contact with the team doctor/physiotherapist responsible for COVID-19 compliance).

Following the completion of the tournaments, the team physician responsible for each SARS-CoV-2 positive player was contacted. An unstructured interview was performed with the team physician to determine how the player likely contracted the SARS-CoV-2 infection. Answers were retrospectively coded into groups of similar methods of transmission, namely non-rugby related and rugby-related (details in the Supplementary File 1).

The main outcome measure was the number of SARS-CoV-2 infections in the rugby players during the overall study period during and in each of the three phases of the study (reported as an incidence). The incidence pattern in rugby players was compared to the incidence pattern of SARS-CoV-2 infection in the general population at each phase of the study. A further outcome was the period prevalence of SARS-CoV-2 infection in the rugby players (% positive players). Additional outcomes were: 1) the mode of transmission for each SARS-CoV-2 positive player, 2) the symptoms (type, duration and severity) in infected players, and 3) the days to return-to-training in infected players.

Demographic and respiratory health data from the online surveys were exported from REDCap and then analysed in SAS. The demographic data of the all players and the SARS-CoV-2 positive players were described and compared using a Wilcoxon rank sum test for non-parametric data, and a Satterthwaite test for the parametric data. The incidence of SARS-CoV-2 positive players was calculated using a Poisson distribution and presented as per 1000 player days (95%CI). Respiratory symptom data were presented as the number, duration (median; interquartile range) and severity (median; interquartile range). The return-to-training days were calculated as a median (lower quartile – upper quartile). The transmission data were all qualitative and therefore were transcribed, and then coded into groups, and narratively synthesized.

## 3. Results

Seven teams (approximately 30–40 players per team) participated in the two competitions. One full team did not agree to participate in the study. Of the remaining 6 teams (205 players), 20 players did not consent to their data being used for research. Therefore, the study population was 185 unique consenting players (90 % of players from the 6 teams).

The demographics of all players, the SARS-CoV-2 positive and negative groups are reported in Table 1. There were no significant differences in demographic variables between the SARS-CoV-2 negative group and the SARS-CoV-2 positive player group. No SARS-CoV-2 vaccinations were available in the country at the time and therefore all players were unvaccinated.

In this population, 42 rugby players tested positive for SARS-CoV-2 (22.7 %) over the 184-day period (185 players, 184 days = 34,040 player days). The overall incidence of SARS-CoV-2 infection in the cohort of rugby players, over the 184 days was 1.23 (95%CI: 0.86–1.61) per 1000 player days. The incidence during each phase was as follows: non-contact training phase = 0 (positives = 0; 5180 player days), contact training phase = 1.04 (95%CI: 0.36–1.71) (positives = 9; 8695

**Table 1**
Demographics of the rugby players with subgroups (SARS-CoV-2 positive and SARS-CoV-2 negative).

| | All (n = 185) | SARS-CoV-2 Positive (n = 42) | SARS-CoV-2 Negative (n = 143) | SARS-CoV-2 Positive vs. Negative (p-value) |
|---|---|---|---|---|
| Age (years) (median, IQR) | 25 (5) | 25 (5) | 25 (5) | 0.9961 |
| Height (cm) (median, IQR) | 184 (11) | 183 (12.5) | 185 (9.5) | 0.6001 |
| Weight (kg) (mean. SD) | 102.0 (13.9) | 105.3 (13.2) | 101 (14.1) | 0.1021 |
| Sporting experience (years) (median, IQR) | 6 (5) | 6 (4.5) | 6 (6) | 0.6297 |
| Co-morbidities (n) (median, IQR) | 0 (0) | 0 (1) | 0 (0) | 0.1049 |

Some participants had missing data.
IQR: interquartile range.

player days), and competition phase = 1.54 (95%CI: 1.00–2.10) (positives = 31; 20,165 player days). The date of 2 SARS-CoV-2 infections could not be verified (these 2 are excluded from any date-related analyses). The predominant variant in South Africa throughout the study was the Beta variant.

In the Super Rugby Unlocked tournament, there were three matches cancelled due to SARS-CoV-2 infections (21 matches in total, 14.3 %), and in the Carling Currie Cup, there were a further two matches cancelled (24 matches in total, 8.3 %). Therefore, a total of 11.4 % of matches were cancelled.

The pattern of infection rates in the three study phases of: a) the proportion of players with SARS-CoV-2 infections in the rugby cohort, and b) the incidence of new SARS-CoV-2 infections in the general population (average new cases per 100,000 person days) is presented in Fig. 1. For the rugby cohort, no cases of SARS-CoV-2 were reported in the non-contact training phase, with an initial peak at the beginning on contact training, and then a gradual increase from week 17, with another peak at week 23. Generally, the pattern of SARS-CoV-2 infection rates followed a similar trend to that of the population.

Through contact tracing, the origin of the 42 cases was established. The percentage of SARS-CoV-2 infections attributed to rugby or non-rugby-related activities is shown in Fig. 2. A total of 20 (47.6 %) SARS-CoV-2 infections in players were non-rugby related and 22 (52.4 %) were rugby-related. Of the 22 rugby-related SARS-CoV-2 infections, 13 were off-field rugby-related and 9 were on-field rugby-related. Eight out of the 9 on-field rugby related infections occurred in forward players. The 3 unconfirmed infections were classified as on-field rugby-related contacts by the physician (2 during a match and 1 during training), however they fell outside of the guidelines (e.g. 1 s under the time required to be deemed a contact, wearing a face mask during training etc.),[14] and therefore were classified as "unconfirmed".

Seven players (16.7 %) were asymptomatic, eight had only nose/throat symptoms (19.1 %), five had chest and neck symptoms (no systemic, but possibly nose and throat symptoms; 11.9 %) and 22 had systemic symptoms (52.4 %). Of the 22, three had a total of ≥10 symptoms (7.1 %). The number (n), duration and severity of symptoms reported by the 35 symptomatic players (83.3 %) are reported in Supplementary Table 1. None of the players were hospitalized or died.

Of the 42 SARS-CoV-2 positive players, 31 players reported their days to return-to-training. The median days (lower and upper quartiles) to return-to-training were 14 days (10–16).

## 4. Discussion

The main aim of the study was to describe the incidence of SARS-CoV-2 infections in rugby players over 6 months of a staged return-to-training and competition following a national lockdown during the COVID-19 pandemic. The incidence of SARS-CoV-2 infections was higher in the contact and competition phases compared to the non-contact phase. The pattern of infections in rugby players was similar to those reported in the general population. Transmission of SARS-CoV-2 infections in players was deemed to be rugby-related in 52.4 % cases. Of the on-field, only two were potentially match-related transmission and eight out of nine on-field infections occurred in forward players (both match-related were forwards). Most (83.3 %) players were symptomatic and 52 % of the players reported systemic symptoms. The median return-to-training days in SARS-CoV-2 positive players was 14 days.

The overall incidence of SARS-CoV-2 infections over the 184 days was 1.23 per 1000 player days. The incidence of SARS-CoV-2 infections in elite sports is not reported in most studies. In a study of high school athletes, an incidence of 0.3 per 1000 player days was reported.[15] In only one other

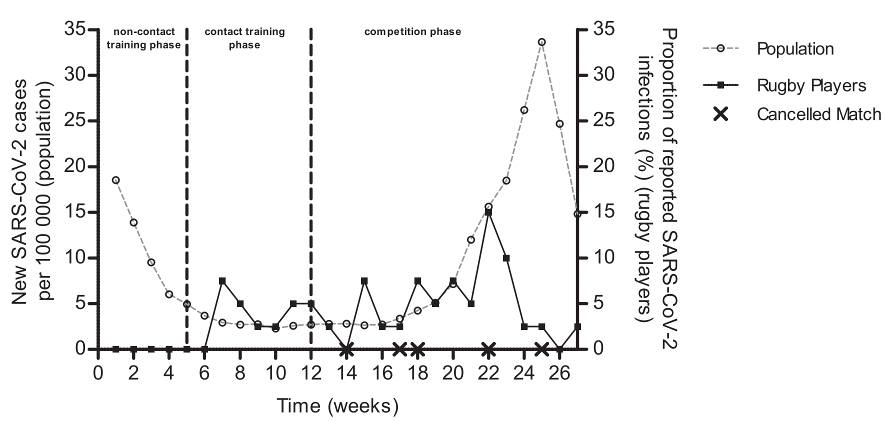


**Fig. 1.** The pattern of infection rates in the three study phases: a) the average number of new cases per 100,000 per week in the population (based on a population of 59.31 million), and b) proportion of SARS-CoV-2 positives reported in the cohort of rugby players (n = 40; 2 missing dates).
The different rugby regulation phases are depicted: non-contact training only, contact training, and competition phase. Week 1 is 19–25 July 2020, and Week 27 is 17–23 January 2021.
Where a match has been cancelled due to SARS-CoV-2 infection/s in a team has also been marked.
Weeks were approximated to match the data collection timeline:
Non-contact training: week 1 – week 5 (19–25 July – 16-22 Aug 2020)
Contact training: week 5 – week 12 (16–22 Aug – 4-10 Oct 2020)
Competition: week 12 – week 27 (4–10 Oct 2020–17-23 Jan 2021).

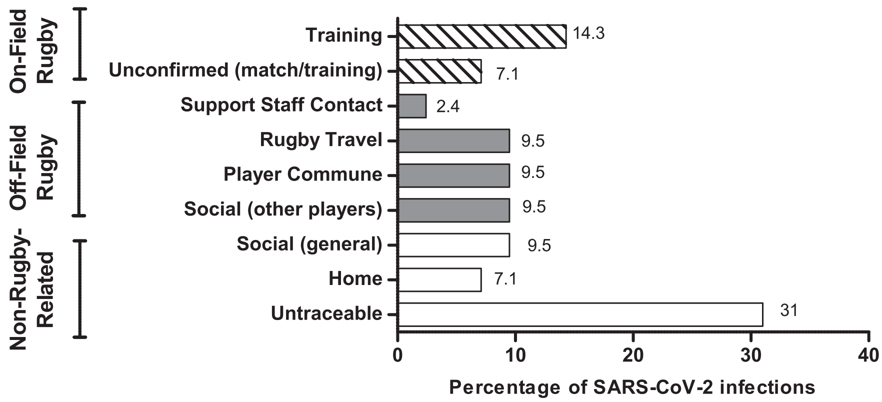


**Fig. 2.** The percentage of SARS-CoV-2 infections attributed to rugby (on-field and off-field) and non-rugby-related activities (n = 42).

study, the incidence was reported as 457 per 100,000 players per week (0.7 per 1000 player days),[2] whilst in other studies, only the percentage of positive cases is reported. This is a period prevalence, but notably the period of observation varies. When percentage of positives is compared, we report a period prevalence of 22.7 % (over 6 months), compared to 11.7 % in professional Brazilian football players (6 months) and a range of 3.4–9.5 % in youth ice hockey player (1 month).[16] In several other studies, the infection rates within a sporting population, over a defined study period, have also been compared to rates in the general population, all concluding a similar message.[17,18] Whilst the different studies all used different methodologies to depict this pattern between sports teams and population, the sporting population usually had a similar pattern in infection rate. Our study showed this similar pattern, but with the players' having a higher rate than the population, which is often attributed to the increased testing measures implemented. Our study also showed the pattern mirrored the population, but notably there were two peaks that were not observed in the general population: 1) a peak when contact training was incorporated (on-field transmission responsible), and 2) a mid-competition peak, which was during the upswing of the "second wave" (weeks 18–25) within South Africa (off-field transmission mostly responsible). It is hypothesized that the off-field transmission is easier to detect and then mitigate (peak faster and then drop) in a sporting population due to the increased testing and ability to implement mitigation strategies in this controlled environment, compared to the general population. The predominant SARS-CoV-2 variant during our study was the Beta variant, and this must be taken into consideration when comparing studies and the incidence/transmission rates in various geographical locations and time-points.

The risk of SARS-CoV-2 transmission in sports continues to be debated and is of concern to both sporting federations and public health experts as training and competition returns to normality during a pandemic. This study illustrated how rugby-related activities, and specifically contact training, were often responsible for transmission (52 %). Training appeared to be the most high-risk activity, with almost all of the on-field infected players being forwards (8 of 9 players). We suggest that this could be attributed to the scrum situation, where there are prolonged periods of close physical contact of up to 16 players,[19] requiring high energy expenditure, and therefore increased ventilation rates. Teams identified the scrum situation as a "high risk" activity, and many adjusted weekly training schedules to only start contact training once the COVID-19 status of the team was known, to further avoid team spread (a risk mitigation strategy). We note that in a previous rugby league study on a SARS-CoV-2 outbreak, no significant rugby-related transmission was reported. However, the key difference in this study was the removal of scrums as a specific risk mitigation strategy.[9] In non-collision sports, such as football, there are two studies where no infections were confirmed to be due to sport specific events.[2,4] We suggest that the risk of transmission in football would be lower because there are limited number and short-duration physical contact periods between teams during training and competition. The collision/physical nature of rugby immediately puts it at a higher risk for transmission. A more comparable sport to rugby would be ice hockey, where one study showed that an asymptomatic player was responsible for a mass outbreak, resulting in 49 players testing positive (within team and match transmission).[3] Our finding that a high percentage of infections occurred during rugby-related activities, particularly in forwards during training (less so during matches) should be further investigated and specific risk mitigation strategies designed for reduce the risk on forward players.

A further unique aspect about our data was that SARS-CoV-2 infections resulted in the cancellation of 11 % of matches. No other study has described this effect. Whilst it is known from media reports that matches have been cancelled in other rugby competitions due to outbreaks, the extent of the problem in both rugby and other sports is otherwise unknown. It must be noted that in rugby one infection can result in a cancelled match because of the specialized nature of front row positions. If a COVID-19 positive player was in contact with a teammate/s who play the same position (particularly front-row forwards), this results in the players needing to isolate, and therefore the team cannot field a front-row player (a requirement by World Rugby), and therefore the match is cancelled. Whilst the reasons for these cancelations include regulations, the cancelations would not have happened if not initiated by SARS-CoV-2 infections.

In our cohort, only 7 players were asymptomatic, and 35 were symptomatic (83 %), and 23 had systemic symptoms. In a study in Qatari footballers, only 42 % were symptomatic, and even fewer of those had systemic symptoms.[2] Another study reported only 65 of 165 (38 %) SARS-CoV-2 infections as symptomatic athletes, however, they deemed a symptomatic case as a player who had ≥2 symptoms.[4] Whilst symptoms are very poorly discussed in studies, it does appear that we had fewer asymptomatic players in our study, and they had more symptoms (including systemic symptoms). The reasons for these differences in % asymptomatic players is not clear. Some studies have reported severity (using varying definitions of mild, moderate and severe) and one study reported a staff member to have died,[17] however none of the studies report any athletes having severe disease. There is a need to standardize reporting of symptoms and severity scale for athletes.

Return-to-training is an important consideration for athletes recovering from SARS-CoV-2 infection and general acute respiratory infections. The median days to return-to-training was 14 days, which is much shorter than previously published data where athletes took between 18 and 30 days to return.[11,20] The SA Rugby protocol followed best practice and evidence available for return-to-training. This included a 10-day mandatory isolation, after which players began graduated return-to-play protocols if all medical tests and review were clear. Our data indicate that most of these players returned to training after 6 days of completing the mandatory 10-day self-isolation period. Therefore, when players are managed in a professional environment compared to recreational athletes, the return-to-training time can be safely accelerated. However, there are still limited data available on the time to return-to-play / training from SARS-CoV-2 infection in athletes and studies should look to report this measure as to assist sport and exercise medicine physicians to anticipate the timeline for players.

The main limitation of this study is that one full team did not agree to participate in the study, and therefore these results only represent the teams participating. However, in the remaining 6 teams, >90 % of players did consent to be participants. It is unknown how different the results would be if all 7 teams and players had consented to be in the study. A further limitation of the study is that whilst the pattern of infections between the rugby cohort and the population were similar, the rugby players were all tested on a weekly basis, whereas the population data are only based on individuals who presented to facilities for testing (mostly symptomatic, or close contacts of positive SARS-CoV-2 patients). The strengths of these data are that all infections were by physician-verified PCR tests, and the transmission data were gathered from the physicians working and travelling with the respective teams and players.

## 5. Conclusion

The incidence of SARS-CoV-2 infections in professional rugby union players was higher than previously reported in other sports and followed a similar pattern to the population. In our study, rugby-related activities were responsible for 52 % of infections, with training contributing the most. Rugby-related infections occurred mostly in forwards and 11 % of matches were cancelled due to SARS-CoV-2 infections. 83 % of the infected players were symptomatic, with 52 % of all positives having systemic symptoms. In conclusion, the contact nature of rugby union represents a higher risk for transmission of the SARS-CoV-2 virus, therefore risk mitigation strategies in contact sports need to be reviewed, adjusted and strictly implemented to decrease the risk in contact sports.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jsams.2022.06.004.

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## Declaration of Interest Statement

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Martin Schwellnus reports financial support was provided by IOC research centres. Martin Schwellnus reports statistical analysis and writing assistance were provided by South African Medical Research Council.

## Credit authorship contribution statement

NS: study concept, study planning, data cleaning, data analysis including statistical analysis, data interpretation, manuscript (first draft), manuscript editing.

MS: responsible for the overall content as guarantor, study concept, study planning, data cleaning, data interpretation, manuscript editing, facilitating funding

CR: study planning, data cleaning, data interpretation, manuscript editing.

SS: data cleaning, data analysis including statistical analysis, data interpretation, manuscript (first draft), manuscript editing.

ES: study planning, data analysis including statistical analysis, data interpretation, manuscript (first draft), manuscript editing.

## Data sharing statement

No additional data are available.

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