

SARS-Cov-2 Outbreaks in Sport and Exercise Settings: A Cross-sectional Study

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ABSTRACT

Objective: This study aimed to retrospectively explore the differences between COVID-19 outbreaks, based on their association with sport/exercise practice and whether expansion among confirmed cases was observed in these settings.

Method: Data from 5,327 COVID-19 outbreaks from the Epidemiological Surveillance Network of the Canary Islands were extracted between 31 January 2020 and 15 May 2021. We compared outbreaks in confirmed cases, close contacts, hospitalisations, admissions to Intensive Care Unit (ICU) and deaths.

Results: The median number of cases per outbreak in sport/exercise settings with transmission was significantly larger (9 [5–16]) compared with outbreaks in other settings (4 [3–7]). Similarly, age of first case (35 [25–44] vs. 42 [30–55] years) and number of close contacts (30 [10–62] vs. 10 [5–21]) presented significant differences. However, no differences were found in number of hospitalisations, admissions to ICU and deaths per outbreak.

Conclusions: Sport and exercise settings may pose a significant burden for contact tracing investigators since they tend to produce larger outbreaks. Regulations did not seem to completely control transmission. To enhance cooperation, specific recommendations and tailored advice are required according to the particular sport or exercise, the environment where it is practised and the available means of the facilities. Policies should encourage alternatives for safer sport/exercise practices.

Keywords: COVID-19; SARS-CoV-2; Sport; Exercise; Outbreak; Infectious Disease Transmission; Surveillance.

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I. INTRODUCTION

During the first pandemic wave of spring 2020, the Government of Spain declared a state of alarm in mid-March, establishing a home quarantine to control the transmission of the virus (Government of Spain, 2020; Moscoso-Sánchez, 2020; Pons *et al.*, 2020). By the beginning of May 2020, the population was allowed to return to exercise (e.g. running, cycling) individually and limited by time slots (Government of Spain, 2020).

In the Canary Islands, control measures were progressively established according to the weekly epidemiological situation for each particular island. Many of these measures had a direct impact on sports practice (Government of the Canary Islands, 2021). It was estimated that reopening of gyms and indoor

sports centres could represent a potential risk (Blocken *et al.*, 2020; Jang *et al.*, 2020; Noorimotlagh *et al.*, 2020; Donadu *et al.*, 2020).

The aim of the present study is to retrospectively explore the differences between COVID-19 outbreaks, classified as follows: a) outbreaks where sport/exercise practice was involved and expanded (secondary transmission) among confirmed cases (SEE); b) outbreaks where sport/exercise practice was documented but no secondary transmission was determined (SENE); and c) outbreaks where no sport/exercise practice was observed (NSE). Secondary goals of the study are: i) to determine the impact of restrictive measures on the incidence of COVID-19 cases in sports/exercise settings; ii) to analyse the association between sports/exercise and the number of confirmed cases and close contacts per outbreak; iii) to analyse the effect of sport/exercise on the number of clinical events per outbreak (i.e., hospital admissions, admissions to Intensive Care Units [ICU], and deaths); and iv) to describe the scope of exposure for SEE outbreaks.

II. METHODS

A. Epidemiological Surveillance

The epidemiological surveillance network of the Canary Islands (ReVECa) is responsible for detection, notification and investigation of transmissible disease cases, outbreaks, and causing microorganisms. ReVECa is integrated, together with other Spanish regions, into the broader National Epidemiological Surveillance Network (RENAVE), which works in coordination with the European Centre for Disease Prevention and Control (ECDC). Contact tracing process, case confirmation method and identification of sport and exercise cases are described in the appendix.

B. Inclusion and Exclusion Criteria

We included all records of COVID-19 confirmed cases and their close contacts found in our database that were declared after 31 January 2020 (date of first confirmed case). Records were excluded when no epidemiological link was found to other cases, or the number of linked cases within any outbreak was fewer than three. Active outbreaks (i.e., presenting new cases during the last 14 days prior to data extraction) were also excluded from the study. Additionally, outbreaks were excluded when their duration indicated inaccurate dates of symptom onset or date of diagnosis.

C. Case and Outbreak Data Extraction

Between 31 January 2020 and 15 May 2021, covering the first four COVID-19 waves in the Canary Islands, we found 43,941 cases in our database from 8,396 outbreaks meeting the inclusion criteria, as shown in Fig. 1. During the data extraction and classification processes, the reviewed records were curated by the investigators, and all detected documentation errors were tracked and fixed. For each outbreak, the following information was extracted: outbreak identifier; number of confirmed cases, hospitalisations, ICU admissions and deaths; number of cases by age group; age statistics per outbreak (minimum, maximum and 1–3 quartiles); date of diagnosis of first and last cases within the outbreak; number of male and female cases; and location of first case (island and municipality).

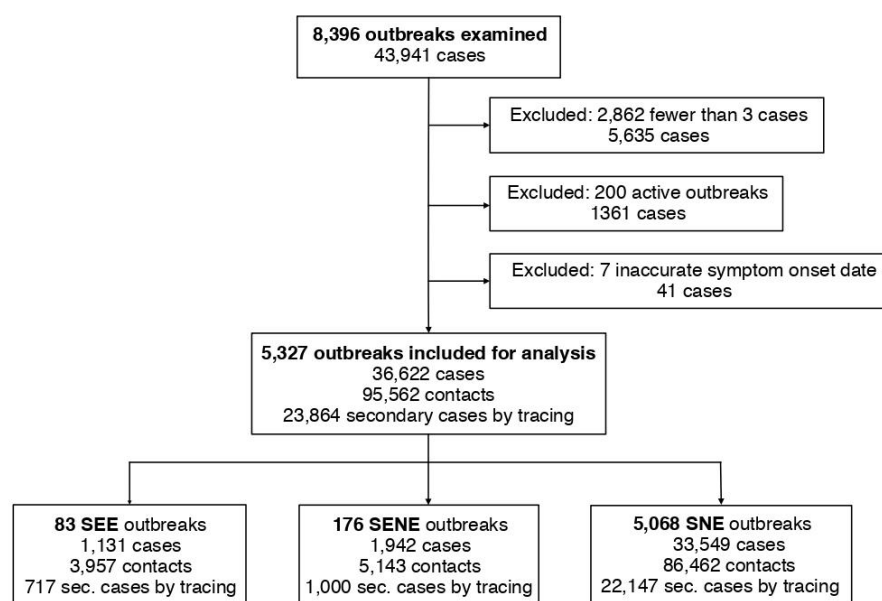


Fig. 1. Flow diagram of the study.

Note: NSE = outbreaks where no sport/exercise practice was observed; SEE = outbreaks where sport/exercise practice was involved and produced secondary transmission among confirmed cases. SENE = outbreaks where sport/exercise practice was documented but no secondary transmission was determined.

Following the exclusion criteria, 2,862 outbreaks were excluded because they presented less than three cases; 200 still active outbreaks were also excluded; and another 7 outbreaks presented inaccurate dates. Hence, 36,622 cases from 5,327 outbreaks were included in our final analysis.

To classify outbreaks, a search in ReVeCA database was performed, looking for confirmed-case records where either the documented comments or occupation included sport- or exercise-related terms (e.g., sport, gym, training, etc.), using wildcards to cover as many word variants as possible. Records were classified as sport/exercise related when the person acknowledged practising sports or performing exercise with another confirmed case within a 14-day time window before the date of symptom onset, or date of diagnosis if the person was asymptomatic. When the case did not mention such behaviour, the record was classified as unrelated to sport/exercise. We identified 3,073 sport/exercise related cases belonging to 259 outbreaks.

Outbreaks including exclusively unrelated to sport/exercise records were classified into NSE category (n=5,068). When sport/exercise linked transmission was verified between at least two cases, outbreaks were classified into sport/exercise outbreaks with expansion (SEE category, n=83), and sport/exercise outbreaks without expansion otherwise (SENE category, n=176).

D. Close Contacts Data Extraction

For each of the 5,327 analysed outbreaks, all close contacts generated by contact tracing (n=147,864) were extracted. Since identical contacts can often be referred by more than one confirmed case, all duplicated contacts within each outbreak were excluded. From 95,562 unique contacts, individuals who either remained as close contacts (n=71,698) or converted into secondary cases after testing positive for COVID-19 (n=23,864) were identified. Close contacts were also classified according to outbreak categories (Fig. 1). Extracted data included the number of male and female contacts per outbreak, and transmission scope.

E. Sport/Exercise Allowance Data

Based on outbreak dates and islands where they originated, we documented the behavioural and social restrictions in force on the week when the first sport/exercise confirmed case was detected for each outbreak. We then classified the restriction levels into six categories according to the number of people allowed to practise sport/exercise in indoor areas, using the following scale: 0, unrestricted/normal; 1, up to 25 people allowed indoors; 2, $\leq 75\%$ of total capacity; 3, $\leq 50\%$ of total capacity; 4, $\leq 33\%$ of total capacity; 5, not allowed to practise sports/exercise.

F. Data Analysis

For each outbreak category (SEE vs. SENE vs. NSE), total number of cases, contacts and events were summarised as frequency (n) and percentage (%). Within each outbreak, data distributions were summarised using median and interquartile range (IQR). Chi-squared test was used to compare age categories. Medians were compared using Kruskal-Wallis test and Bonferroni-adjusted Dunn's test for pairwise comparisons. Significance level was set at 0.05. The analyses were performed using Stata 15.1 (Stata Corp, College Station, TX, USA).

G. Ethical Statement

Ethical approval for this study was obtained from Comité de Ética de la Investigación con Medicamentos del Complejo Hospitalario Universitario de Canarias (Approval code CHUC_2021_27). All procedures were conducted in accordance with the Declaration of Helsinki. Statistical analyses were performed on anonymised data to protect patient privacy and confidentiality. Consequently, no individual informed consent was required.

III. RESULTS

Overall, the number of analysed cases was 36,622 (48.8% were male; median [IQR] age: 38.5 [29–49], with 5 [3–7] cases per outbreak and a maximum of 410 cases. The number of male (2 [1–4]) and female (2 [2–4]) cases within each outbreak was similar, and the median age of the first case of the outbreak was 42 [29–54] years. The cases generated a total of 95,562 contacts (10 [5–22] per outbreak), with a maximum of 588 contacts. After removing duplicates, 71,698 contacts remained in the analysis (7 [2–16] per outbreak). Of these, 23,864 (25%) resulted in secondary cases (3 [2–5] per outbreak). From all cases, 3,120 (8.52%) required hospitalisation (0 [0–1] per outbreak), with a maximum of 84 admissions in a single outbreak. In total, 634 (1.73%) patients required admission to ICU (per outbreak, 0 [0–0], max. 15). There were 526 (1.44% of total) deaths (median per outbreak, 0 [0–0], max. 31).

A. Outbreak Comparison Based on Sport/Exercise Categories

Table I shows the differences in study outcomes based on outbreak category (SEE vs. SENE vs. NSE). There were statistically significant differences ($p < 0.001$ all) between categories in median number of cases

per outbreak, gender distribution, age distribution (18–39 years group accounted for 42% of SEE cases), age of first case, number of close contacts and secondary confirmed cases per outbreak, and gender of close contacts. No differences were found in number of hospitalisations, admissions to ICU and deaths between outbreak categories. All 5,327 outbreaks are depicted in Fig. 2; for each outbreak category, the inner area represents the number of cases, and the outer area represents the total number of people traced (cases plus contacts).

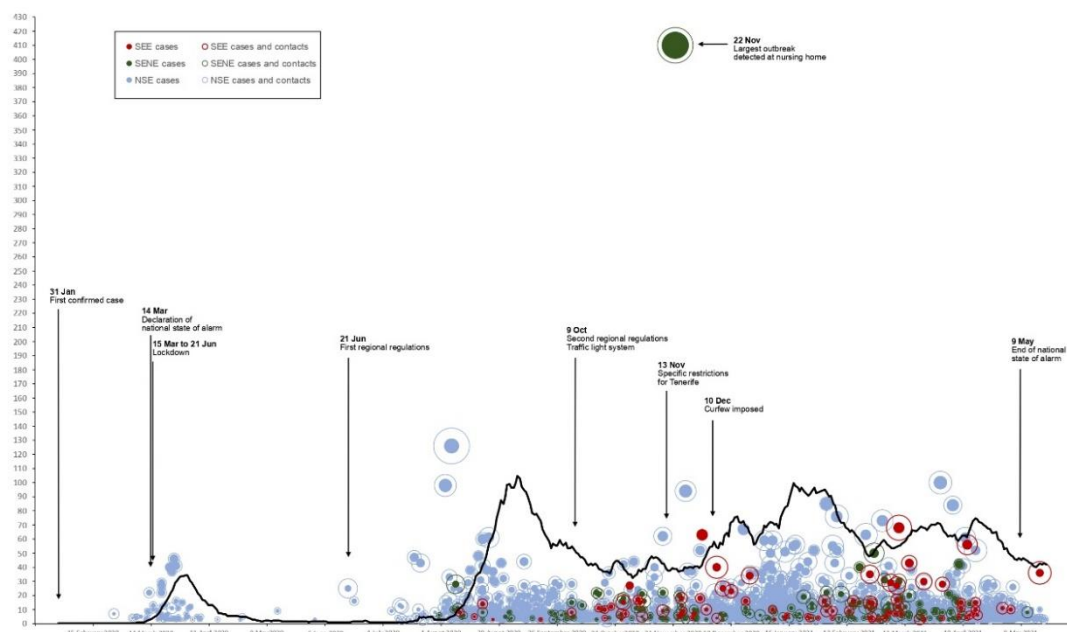


Fig. 2. Outbreak cases and contacts by category.

Note: NSE (blue) = outbreaks where no sport/exercise practice was observed; SEE (red) = outbreaks where sport/exercise practice was involved and produced secondary transmission among confirmed cases; SENE (green) = outbreaks where sport/exercise practice was documented but no secondary transmission was determined; Black line represents 7-day cumulated incidence in the Canary Islands throughout the period of study

The presence of secondary transmission in sport/exercise (SEE vs. SENE) only determined larger number of cases per outbreak (9 [5–16] vs. 6 [4–11], $p=0.019$) and larger number of male cases per outbreak (4 [3–8] vs. 3 [2–5], $p=0.009$). Otherwise, these categories presented no differences in other characteristics.

Both SEE and SENE categories showed differences compared with NSE in number of cases, age of first case within outbreak, outbreak duration, close contacts, and secondary confirmed cases ($p<0.001$ all, Table I). Fig. 3 shows kernel density plots of median years of age and days of duration for each outbreak category. SEE outbreaks were composed of younger people (Figure 3A), and showed longer duration (Fig. 3B).

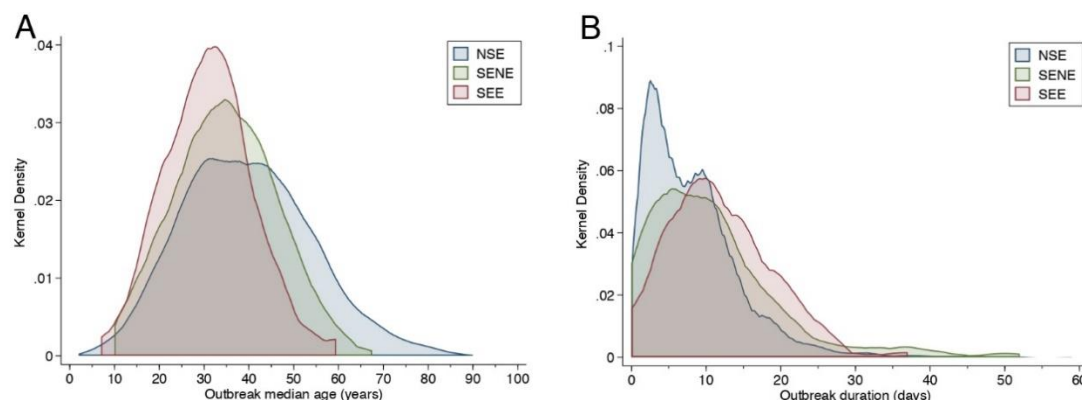


Fig. 3. Kernel density plots for median age (A) and duration (B) by outbreak category.

Note: NSE (blue) = outbreaks where no sport/exercise practice was observed; SEE (red) = outbreaks where sport/exercise practice was involved and produced secondary transmission among confirmed cases; SENE (green) = outbreaks where sport/exercise practice was documented but no secondary transmission was determined.

However, compared to NSE, only SEE showed larger percentage of male cases within outbreaks ($p<0.018$), and only SENE showed larger percentage of male close contacts ($p=0.017$).

TABLE I: COMPARISON OF OUTBREAKS CHARACTERISTICS ACCORDING TO SPORTS/EXERCISE CATEGORY

	Outbreak categories						p	Pairwise comparison		
	SEE		SENE		NSE			SEE vs SENE	SEE vs NSE	SENE vs NSE
Outbreaks, n (%)	83	1.56	176	3.3	5,068	95.14				
Cases										
Confirmed cases, n (%)	1,131	3.09	1,942	5.3	33,549	91.61				
Median (IQR)	9	5–16	6	4–11	4	3–7	<0.001	0.019	<0.001	<0.001
Male cases, n (%)	595	3.33	993	5.56	16,278	91.11				
Median (IQR)	4	3–8	3	2–5	2	1–4	<0.001	0.009	<0.001	<0.001
Female cases, n (%)	536	2.88	947	5.09	17,139	92.04				
Median (IQR)	5	2–9	3	2–6	2	2–4	<0.001	0.120	0.001	<0.001
% male cases, Median (IQR)	54.5	41.1–66.7	50	37.5–65.5	50	33.3–66.7	0.004	0.424	0.011	0.065
% female cases, Median (IQR)	45.5	33.3–58.9	50	34.5–62.5	50	33.3–66.7	0.005	0.461	0.013	0.067
Age of first case, years, Median (IQR)	35	25–44	38.5	24–49	42	30–55	<0.001	0.219	<0.001	0.001
Outbreak duration, days, Median (IQR)	11	7–16	9.5	4–14	7	3–11	<0.001	0.062	<0.001	<0.001
Age group, years, n (%)							<0.001			
0–11	113	9.99	176	9.06	3,379	10.07				
12–17	144	12.73	233	12	2,681	7.99				
18–39	476	42.09	547	28.17	11,181	33.33				
40–59	285	25.2	555	28.58	10,431	31.09				
60–79	96	8.49	262	13.49	4,434	13.22				
≥ 80	17	1.5	167	8.6	1,311	3.91				
Events										
Hospitalisation, n (%)	53	1.7	168	5.38	2,899	92.92				
Median (IQR)	0	0–1	0	0–1	0	0–1	0.360	0.715	0.292	0.789
ICU, n (%)	12	1.89	23	3.63	599	94.48				
Median (IQR)	0	0–0	0	0–0	0	0–0	0.381	0.799	0.332	0.744
Death, n (%)	8	1.52	41	7.79	477	90.68				
Median (IQR)	0	0–0	0	0–0	0	0–0	0.998	>0.999	>0.999	>0.999
Close contacts										
Close contacts without duplicates, n (%)	3,957	4.14	5,143	5.38	86,462	90.48				
Median (IQR)	30	10–62	17.5	10–36	10	5–21	<0.001	0.222	<0.001	<0.001
Close contacts negative for COVID-19, n (%)	3,240	4.52	4,143	5.78	64,315	89.7				
Median (IQR)	23	8–52	13.5	7–30	6	2–16	<0.001	0.177	<0.001	<0.001
Secondary confirmed cases, n (%)	717	3	1,000	4.19	22,147	92.81				
Median (IQR)	5	2–9	4	2–7	3	2–5	<0.001	0.177	<0.001	<0.001
Male close contacts, n (%)	1,967	4.27	2,731	5.93	41,380	89.8				
Median (IQR)	13	4–27	10	4–18.5	5	2–10	<0.001	0.557	<0.001	<0.001
Female close contacts, n (%)	1,943	4.05	2,345	4.89	43,668	91.06				
Median (IQR)	15	5–35	8	4–16.5	5	2–11	<0.001	0.065	<0.001	<0.001
% male close contacts, Median (IQR)	46.6	36.8–57.9	50	41.4–62.6	48.7	37.5–57.1	0.042	0.171	>0.999	0.018
% female close contacts, Median (IQR)	52.4	42.1–62.7	50	35.4–58.1	50	41.2–61.5	0.040	0.177	>0.999	0.017

NSE = outbreaks where no sport/exercise practice was observed; SEE = outbreaks where sport/exercise practice was involved and produced secondary transmission among confirmed cases. SENE = outbreaks where sport/exercise practice was documented but no secondary transmission was determined; IQR = interquartile range. p-values were calculated from Kruskal-Wallis test, and Bonferroni-adjusted Dunn's test for pairwise comparison; chi-squared test was used for age-group comparison. Boldface indicates statistical significance (p<0.05).

TABLE II: COMPARISON OF CHARACTERISTICS OF COVID-19 OUTBREAKS IN SPORT/EXERCISE SETTINGS WITH AND WITHOUT SECONDARY TRANSMISSION

SECONDARY TRANSMISSION					
COVID-19 outbreaks involving sport/exercise cases (n=259)					p
Further expansion in sport/exercise		No further expansion in sport/exercise			
Outbreaks, n (%)	83	32.1	176	67.9	0.052
Sport vs. exercise, n (%)					
Sport	62	74.7	110	62.5	
Exercise	21	25.3	66	37.5	
Sport/exercise type					
Professional sport, n (%)	28	33.7	23	13.1	<0.001
Team sport, n (%)	46	55.4	95	54.0	0.828
Contact sport, n (%)	5	6.0	5	2.8	0.215
Gym physical activity, n (%)	28	33.7	61	34.7	0.884
Indoor physical activity, n (%)	43	51.8	102	58.0	0.352
Sport/exercise influence					
% Athletes/exercisers, median (IQR)	40	20–66.7	16.6	10-25	<0.001
Athlete/exerciser was index case, n (%)	53	63.9	56	31.8	<0.001

Boldface indicates statistical significance (p<0.05).

As shown in Table II, 74.4% of SEE and 62.5% of SENE outbreaks were found to spread through sports, and the difference was not statistically significant ($p=0.052$). Among sport/exercise categories, only professional sports were shown to be more frequent in SEE outbreaks (33.7% vs. 13.1%, $p<0.001$). Nevertheless, the rate of athletes or exercisers within the outbreak was 40% in SEE category, while it was lower in SENE (16.6%), $p<0.001$. Similarly, index case was an athlete or an exerciser more frequently in SEE (63.9%) compared with SENE (31.8%), $p<0.001$.

B. Description of Large Outbreaks with Greater Sport Secondary Transmission

There were seven SEE outbreaks in which more than 20 confirmed cases were reported. Five of these outbreaks included $\geq 25\%$ of athletes/exercisers. Three of them involved professional football (soccer) teams.

A single outbreak included 40 confirmed cases, of which 21 cases (52.5%) belonged to a football team. This outbreak took place when alert levels had not yet been established on the island. All team members shared the dressing room without complying with physical distancing and face mask wearing, and some of them shared a bottle of water. In addition, a lunch among friends was documented, which included several players from the aforementioned team.

Among another outbreak with 68 confirmed cases, 6 cases belonged to one team and 11 more to the opposing team from a football match (25% of athletes affected). This outbreak had three hospitalisations and one admission to ICU. A third outbreak involving football had 36 cases, of which 14 (38.9%) belonged to a football team. Two hospitalisations and one admission to ICU were documented. These last two outbreaks took place while the island was at alert level 2. The outdoor practice of sports and exercise at alert level 2 was limited to 75% of allowed capacity.

Two large outbreaks were associated with exercise at fitness centres. The first of them involved 27 cases, of which 9 (33.3%) were gym clients or instructors; some symptomatic cases refused to isolate. This outbreak took place under a high transmission level period, when indoor fitness activities were allowed in groups up to 25 people while ensuring safe distance, provided that 2/3 of people allowance was not exceeded.

The second of these outbreaks had 43 cases, of which 19 (44.2%) were clients or instructors. There were two hospitalisations from this outbreak. This outbreak took place when the island was set at alert level 2+. At this level, practising exercise or sports indoors when individuals could be within 2 m was allowed in groups of up to four people, including the instructor, while permanently wearing a face mask. The interviewed clients reported that mask wearing and physical distance requirements were not adequately fulfilled. Some symptomatic cases attended the gym before being diagnosed with COVID-19.

IV. DISCUSSION

The present study showed that the median number of cases and close contacts from sport- and exercise-related outbreaks was larger compared with other outbreaks. Moreover, largest numbers correspond to outbreaks where sport/exercise was directly involved in the secondary transmission of the outbreak and not just a consequence of the large size of the outbreaks that spread to multiple settings, including sports and exercise.

Despite the fact that the median number of cases in SEE outbreaks was significantly larger, no differences were observed with respect to SENE and NSE outbreaks in number of hospitalisations, admissions to ICU and deaths. This result can be explained because the cases in SEE outbreaks tend to be younger (almost two-thirds of SEE are under 40 years of age) (Jones *et al.*, 2021; Goldstein *et al.*, 2021), and because sports practice is generally associated with a healthy lifestyle (Jorstad & van den Aardweg, 2020; Hull *et al.*, 2021; Ufnalska *et al.*, 2020). The results are also consistent with other studies such as those by Danesh *et al.* (2020), where age, sex, and the presence of comorbidities were shown as risk factors for hospitalisations. Furthermore, according to Sallis *et al.* (2020) physical activity is associated with a lower risk of severe cases of COVID-19, (Pinto *et al.*, 2021) and multiple reasons support the need for keeping the population active (McGuine *et al.*, 2021; Richardson *et al.*, 2021; Chen *et al.*, 2020).

In our study, when comparing SEE with SENE outbreaks, no evidence of greater secondary transmission was found at indoor exercise settings. These findings differ from previous studies indicating lower risk of transmission for outdoor sports (Sasser *et al.*, 2020; England *et al.*, 2021) and identifying closed spaces as a relevant factor for the increase of airborne transmission of SARS-CoV-2 (Jang *et al.*, 2022; Noorimotlagh *et al.*, 2020; Brlek *et al.*, 2020). These unexpected results may be explained by the fact that prevention measures (e.g., reduced allowance, mandatory use of face masks during exercise...) during the pandemic have been more restrictive in indoor sport settings, thus reducing the expected high transmission rate.

In SEE outbreaks, this study also found a trend for higher percentage of sports (vs. exercise), and significantly higher rate of outbreaks from professional sports. Multiple studies showed that the majority of exposures among athletes occur in social gatherings or between roommates, and are not due to sports

practice itself (Donadu *et al.*, 2020; Brlek *et al.*, 2020; Atherstone *et al.*, 2020). Additionally, higher risk could also be expected due to increased opportunities for close physical contact, similar to other group living environments (Akaishi *et al.*, 2021).

At the regional level, alert levels were set on a weekly basis derived from the particular epidemiological situation and, as a consequence, restrictions were imposed on indoor as well as outdoor sports/exercise activities, especially for those that are practised collectively (including the closure of fitness centres when necessary). When comparing the SEE outbreaks from June to December 2020, although the restrictive measures were softer than from January to May 2021, a decrease in the number of cases per outbreak was not observed. It is possible that due to increased pandemic fatigue (WHO Regional Office for Europe, 2020) athletes failed to comply with the restrictions.

A. Limitations

Since multiple concurrent sources of exposure (sports/exercise, school, family, social, etc.) were frequently identified among the cases, it is therefore difficult to ascertain where the transmissions took place. Sports, and especially team sports, involve a series of social behaviours, and sharing transportation, leisure activities and meals. Given the limitations and possible inaccuracy of tracking, expansion due to sport settings might have been overestimated in this study.

It is also possible that many of the outbreaks had common epidemiological links, which could have been overlooked during the screening. The telephone interviews collected a series of mandatory data for the Ministry of Health but the origin of the transmission was not always determined. At the same time, information on close contacts was self-reported, which may have led to recall bias. Although these sources of bias would equally affect athletes and non-athletes, it is however possible that transmission data were underestimated.

B. Practical Application

Regulations by themselves did not seem to completely reduce transmission because their correct fulfilment could not be assured. Indeed, the qualitative analysis of large outbreaks revealed multiple behaviours among athletes that favoured the spread. Therefore, it is important that measures be accompanied by other interventions (health promotion, education, etc.) to improve both adherence and feasibility. For instance, we recommend the use of registration systems (absent in most facilities where users move uncontrollably through different rooms), which facilitate capacity control and further contact tracing.

The importance of correct airflow, ventilation and filtration in the prevention of virus transmission has also been highlighted along the pandemic (Wang *et al.*, 2021). We also suggest promoting outdoor activities when possible. Moving sports and exercise activities outside should be facilitated, (Reicher & Drury, 2021) in the same way that it was done for restaurants, especially when temperatures permit.

We recommend advising sport/exercise centres on how to increase safety in their facilities using multiple interventions, (Yang *et al.*, 2021) applying technological, building and environment, and behavioural approaches to enhance adherence, and instructing their clients to comply with recommended measures (e.g., proper use of coverings, not to attend if they present symptoms, etc.). Specific recommendations and tailored advice are required according to the particular sport or exercise, the setting where it is practised and the available means of the facility.

Policies should encourage alternatives for safer sport/exercise practices and enhance cooperation of users by promoting healthy behaviours. At the same time, public health policies should also consider that outbreaks in sport/exercise settings could not only overburden contact tracing but increase the risk of secondary transmission to other settings (home, work, school...) and the eventually derived consequences (e.g., workdays and schooldays lost, increased virus spread, and increased risk for more vulnerable population).

APPENDIX

A. Epidemiological Surveillance

The epidemiological surveillance network of the Canary Islands (ReVECa) is responsible for detection, notification and investigation of transmissible disease cases, outbreaks, and causing microorganisms. ReVECa is integrated, together with other Spanish regions, into the broader National Epidemiological Surveillance Network (RENAVE), which works in coordination with the European Centre for Disease Prevention and Control (ECDC).

Within the Basic Surveillance System of ReVECa, notifiable diseases are reported using the EDO System together with an outbreak and epidemic situations notification system, and microbiological tests are recorded in the microbiological information system of the Canary Islands (SIM-Ca).

Once the notifications of positive results for COVID-19 are received, case investigators communicate

with the confirmed cases to confirm isolation, identify the epidemiological link between cases to determine outbreaks, and complete the epidemiological survey data.

B. Contact Tracing Process and Case Confirmation Method

All positive results of active infection diagnostic tests (AIDT) automatically enter ReVeCA and are classified as confirmed cases by default. Then, the information collected in the epidemiological survey is verified by telephone interview with the patient, while checking the clinical records from Primary Care and Specialized Care.

Contact tracing is carried out from 2 days before the onset of symptoms of the case until the moment when the case is isolated, or 2 days before the date of sample collection in asymptomatic cases. The survey also includes a section where the close contacts' affiliation data and the scope of the interaction with the confirmed case are recorded (i.e., cohabitant; sport; not cohabiting family member; friend; workplace or school; healthcare; or unknown).

There were two valid AIDT for COVID-19: the real-time reverse transcriptase-polymerase chain reaction (RT-PCR) or equivalent molecular techniques; and the antigen rapid diagnostic test (Ag-RDT) applied to symptomatic patients, up to 5 days from the onset of symptoms.

C. Identification of Sport and Exercise Cases

For the purpose of this study, three sport categorisations were considered: professional sports (athletes receive payment for their participation on a regular basis, whether on their own or on behalf of others), because regulations for professional and amateur sports were different; team sports (practised between opposing teams, e.g. football, basketball, volleyball), because the number of participants would presumably affect the volume of cases and close contacts; contact sports (require physical contact between players, whether they are scored by hitting an opponent or require players to tackle each other, e.g. boxing and martial arts, rugby), to analyse whether they imply higher transmission risk.

Despite counting for just ~2% of the outbreaks in the Canary Islands and not involving a greater number of admissions to hospital and ICU, SEE outbreaks pose a significant burden for contact tracing investigators, as they multiply their workload. Additionally, the assessment and identification of close contacts in the sports field is more complex than in NSE outbreaks. Typically, the entire team is considered close contacts, including the opposing team.

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CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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