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## Clusters of COVID-19 associated with Purim celebration in the Jewish community in Marseille, France, March 2020



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### ARTICLE INFO

#### Article history:

Received 16 July 2020

Received in revised form 12 August 2020

Accepted 16 August 2020

#### Keywords:

COVID-19

Attack rate

Children

Jewish community

Purim

### ABSTRACT

**Objectives:** We investigated possible COVID-19 epidemic clusters and their common sources of exposure that led to a sudden increase in the incidence of COVID-19 in the Jewish community of Marseille between March 15 and March 20, 2020.

**Methods:** All data were generated as part of routine work at Marseille university hospitals. Biological diagnoses were made by RT-PCR testing. A telephone survey of families in which a laboratory confirmed case was diagnosed, was conducted to determine possible exposure events.

**Results:** As of March 30, 2020, 63 patients were linked to 6 epidemic clusters. The clusters were linked to religious and social activities: a ski trip, organized meals for the Purim Jewish celebration in community and family settings on March 10, a religious service and a charity gala. Notably, 40% of the patients were infected by index patients during the presymptomatic period, which was 2.5 days before symptom onset. When considering household members, all 12 patients who tested negative and who did not develop any relevant clinical symptoms compatible with COVID-19 were 1–16 years of age. The clinical attack rate (symptoms compatible with COVID-19 and biologically confirmed by PCR) in adults was 85% compared to 26% in children.

**Conclusions:** Family and community gatherings for the Purim celebration probably accelerated the spread of COVID-19 in the Marseille Jewish community, leading to multiple epidemic clusters. This investigation of family clusters suggested that all close contacts of patients with confirmed COVID-19 who were not infected were children.

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### Introduction

Worldwide spread of COVID-19, which was declared a pandemic by the World Health Organization on March 11, 2020, has prompted many governments to implement control measures to regulate viral spread with the aim to protect the health and safety of their people. COVID-19 is a communicable disease caused by SARS-CoV-2 and transmitted through respiratory droplets, and it has already been shown that gatherings of people favor its spread. In the current pandemic, mass gatherings present a major public health challenge related to the protection of the health of attendees (Ebrahim and Memish, 2020; Gautret and Steffen, 2016;

Hoang and Gautret, 2018; Mat et al., 2020; Memish et al., 2014). On March 12, 2020, the French government announced the transition to stage 3 of the COVID-19 epidemic and tabled a ministerial order banning public gatherings and closing all nonessential public places. As of March 15, there were 6378 cases of COVID-19 and 285 deaths were officially declared in France (Anon, 2020b); the houses of worship were closed, and general population containment was established on March 17, 2020 (with the aim to limit the spread of COVID-19 (Anon, 2020a).

In Marseille, the first case of COVID-19 was diagnosed on February 2, 2020. From March 15 to March 30, 2020, a total of 29,694 samples were tested for SARS-CoV-2, corresponding to 21,436 patients, of whom 3270 were positive. Alert messages from several people in the Marseille Jewish community about a sudden increase in the number of cases in the community between March 15th and 20th prompted us to investigate possible epidemic

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clusters. With the aim to detect common sources of exposure and activities, we conducted a telephone survey of the affected families. We retrospectively compiled the contact history of the patients to elucidate the origins of such rapid COVID-19 spread in the Marseille Jewish community.

## Materials and methods

### Biological diagnosis

Diagnosis was performed by PCR testing on pharyngeal and/or nasal samples using Virocult swabs (Medical Wire and Equipment Company, Corsham, Wilts, England). Viral RNA was extracted using the EZ1 Virus Mini Kit v2.0 with the EZ1 instrument (QIAGEN, Courtaboeuf, France) or the QIAamp Viral RNA Mini Kit (QIAGEN, Courtaboeuf, France) with the QIAcube automated nucleic acid purifier (QIAGEN). Detection of SARS-CoV-2 RNA was performed with a real-time reverse transcription (RT)-PCR system targeting the envelope protein (E)-encoding gene with the LightCycler Multiplex RNA Virus Master kit and a LightCycler 480 instrument (Roche Diagnostics, Mannheim, Germany), as previously described (Amrane et al., 2020; Lagier et al., 2020).

### Epidemiological investigation

All data were generated as part of routine work at Assistance Publique - Hôpitaux de Marseille (Marseille university hospitals), and the study results were generated from routine standard clinical management and investigations of clusters to prevent further dissemination of the disease. The study was approved by the Ethics committee of the IHU-Méditerranée Infection under the

number 2020–025. A telephone survey of families in which a laboratory confirmed case was diagnosed was conducted. The main investigator (SA) informed participants of this survey and, with their consent, collected information from the 21 days preceding symptom onset on possible exposures, including family or other gatherings, travel, contact with other cases, and names and recent history of clinical conditions of households contacts. The cases in the different clusters were 1) cases with a positive PCR test result (either in our laboratory or in another laboratory and reported by the patients as positive) despite the clinical signs and 2) symptomatic cases in close contact with a biologically documented case.

Whenever possible, we computed the possible transmission tree of the cluster using Bayesian outbreak reconstruction, with the serial interval serving as the parameter for the prior distribution (gamma distribution, mean: 6.36, SD: 4.2 (Bi et al., 2020)). This method aims at reconstructing the transmission tree by building the optimum branching in a weighted oriented graph, where the weight is the credibility of the possible ancestry between the connected nodes. The possible weights are estimated by the prior distribution and the method find the spanning directed tree that optimize the ancestry credibility, using Markov Chain Monte Carlo to draw samples (Jombart et al., 2014). For this process, we used the R software (R Core Team, 2020) with the Outbreaker2 package (Campbell et al., 2018; R Core Team 2020).

### Statistical analysis

The PCR attack rate was calculated as the number of individuals who had a positive PCR result divided by the total number of individuals in the group.

**Table 1**

Main characteristics of cases involved in each cluster.

Cluster	Cluster A	Cluster B	Cluster C	Cluster D	Cluster E	Cluster F	Total
Origin							
Location	Hotel in Alps	Organized reception	Synagogue 1, Marseille	Charity gala	Synagogue 2, Marseille	Private familial and friendly meal	
Date	8–15 March 2020	10 March 2020	10 March 2020	10 March 2020	7 March 2020	10 March 2020	
Cases (n=)							
Number of cases identified	17	17	7	8	5	9	<b>63</b>
Male / Female	8 / 9	9 / 8	3 / 4	3 / 5	2 / 3	6 / 3	<b>31/32</b>
PCR tested / positive tests	16 / 16	15 / 14	7 / 7	8 / 8	5 / 5	9 / 9	<b>60/59</b>
Asymptomatic cases with a positive test	2	0	1	2	1	3	<b>9</b>
Symptomatic cases with a negative test	0	1	0	0	0	0	<b>1</b>
Symptomatic cases with a positive test	14	8	6	6	4	6	<b>44</b>
Symptomatic cases without test	0	2	0	0	0	0	<b>2</b>
Mean age	32	44	32	49	38	46	<b>45 (SD=22)</b>
Number of children (<=16 year-old)	4	1	1	1	1	1	<b>9</b>
Number of asymptomatic children	1	0	0	0	1	0	<b>2</b>
Clinical features							
Clinical data available	13	10	7	8	5	9	<b>52</b>
No clinical signs	2	0	0	2	1	3	<b>8</b>
Fever	7	5	2	4	2	2	<b>22</b>
Headache	4	1	0	1	3	1	<b>10</b>
Cough	8	4	4	3	2	2	<b>23</b>
Runny nose	4	1	4	0	3	2	<b>14</b>
Shortness of breath	5	2	2	1	0	1	<b>11</b>
Chest pain	0	2	0	2	0	0	<b>4</b>
Myalgia	4	4	3	3	2	3	<b>19</b>
Anosmia	3	3	1	2	1	1	<b>11</b>
Ageusia	3	2	1	1	1	0	<b>8</b>
Diarrhea	1	2	0	1	2	2	<b>8</b>

The clinical attack rate was defined as the number of individuals who presented symptoms compatible with COVID-19 and biologically confirmed by PCR divided by the total number of individuals in the group.

The attack rates were calculated in children ( $\leq 16$  years) and in adults. Statistical tests were performed using OpenEpi (Sullivan et al., 2009).

#### Serological assays

Anti SARS-CoV2 IgG antibodies were searched for using EUROIMMUN (Germany) enzyme-linked immunosorbent assay (ELISA) in serum or plasma samples using recombinant S1 domain of the SARS-CoV-2 spike protein as antigen.

## Results

Between March 15 and 30, 2020, 3268 patients with COVID-19 were diagnosed in our laboratory. Between March 15 and 19, 2020, 448 new patients were biologically documented, and a particularly high number of cases was noted in the Jewish community, which alerted the main investigator. We investigated the origins of this high incidence of COVID-19 in community settings. As of March 30, 2020, a total of 63 patients were identified as linked to 6 epidemic clusters. There were 31 males and 32 females (Table 1). The mean age of the 54 patients diagnosed in our laboratory was 45 years (median = 40), ranging from 4 weeks old to 81 years old. Interviewing the patients enabled the identification of commonalities linked to religious and cultural activities.

#### Description of the clusters

##### Cluster A: ski trip

The first cluster, which involved 17 people, originated in a hotel in the French Alps, where several families from Marseille organized a week-long stay from March 8 to 15, 2020, to spend the Purim holidays. During Purim, families and friends gather and partake in a celebratory meal (Michte), exchange gifts of food and drink (Mishloah' manot), provide charity to the poor (Matanot la-evyonim), and participate in a specific public recitation (Megila), usually in a synagogue. Approximately 30 people came from Marseille, and 20 others came from Nice and Paris. On March 16, 2020, the day after they returned home, the first attendees of this tour started to get tested due to respiratory symptoms or contact with confirmed cases. A total of 16 cases were biologically documented with a positive PCR test result for SARS-CoV-2. The interviewed participants helped identify a 17th additional case of a participant from Nice in southeastern France who could not be contacted. Clinical data were not available in 4 cases. The hotel manager, who was present in a professional capacity, was one of the 17 cases. Other staff members may not have been affected.

The 17 cases included 13 adults, including a pregnant woman, and 4 children, with an overall mean age of 32 years. A total of 14 of these 17 patients were part of five families of 3, 5, 5, 5 and 6 people respectively, including two elderly people and 12 children. Notably, all members of each family and household members were not necessarily all infected. The patients who tested negative were mostly children aged 3–16. Some of these patients were in very close contact, such as sharing the same bedroom, with symptomatic (fever and cough) and biologically confirmed cases for the entire stay.

Among the 12 patients for whom the date of symptom onset was known, 10 developed their first symptoms during the stay or on the day of their return, and 2 developed symptoms in the 4 following days (Figure 1). Two patients who tested positive remained asymptomatic.

The index case could not be clearly identified. However, a participant (A1) declared symptoms on March 9, 2020, that is, one day after arrival to the hotel. The Bayesian analysis resulted in a posterior probability of 0.41 and 0.33 that the first two cases (A1 and A16, respectively) were the index cases, in favor of A1. The possible transmission tree of this cluster is presented in Figure 2. The transmission patterns in this figure suggest that case A16 acted as the superspreader of this cluster, having at least 3 secondary cases (A2, A11, and A13) and possibly other (A9). The maximum extent of this outbreak was two generations (A1-A16-A2-A14). No clearly probable primary case was found for case A7.

Among the events that may have contributed to propagating the virus, meals were eaten in the same dining room, often concomitantly with tables shared between families. Specifically, a festive lunch that gathered all trip participants was organized for Purim celebration on March 10, 2020. Moreover, some hotel rooms could be shared by up to 6 people from the same family.

##### Cluster B: Purim meals

A total of 17 people, including 16 adults and 1 child, were epidemiologically linked to cluster B. This cluster originated in a reception room in Marseille during an organized meal that lasted a minimum of 3 h and gathered approximately 140 persons for Purim celebration on March 10, 2020. The mean age of the patients was 44 years. All patients for which clinical data were available were symptomatic. They developed symptoms between March 14 and 16, 2020 (Figure 1).

The only child of the cluster presented with diarrhea and a flu-like illness syndrome that lasted only one day, while the younger siblings remained asymptomatic and tested negative. As soon as a SARS-CoV-2 diagnosis was made for one of the attendees, the organizer of the meal contacted all the participants to warn them. Two secondary cases, which involved family members of one of the participants, were identified. The first developed fever, headache, dyspnea, chest pain, and aches on March 20, 2020. The second developed cough, myalgia, anosmia and ageusia on March 18, 2020.

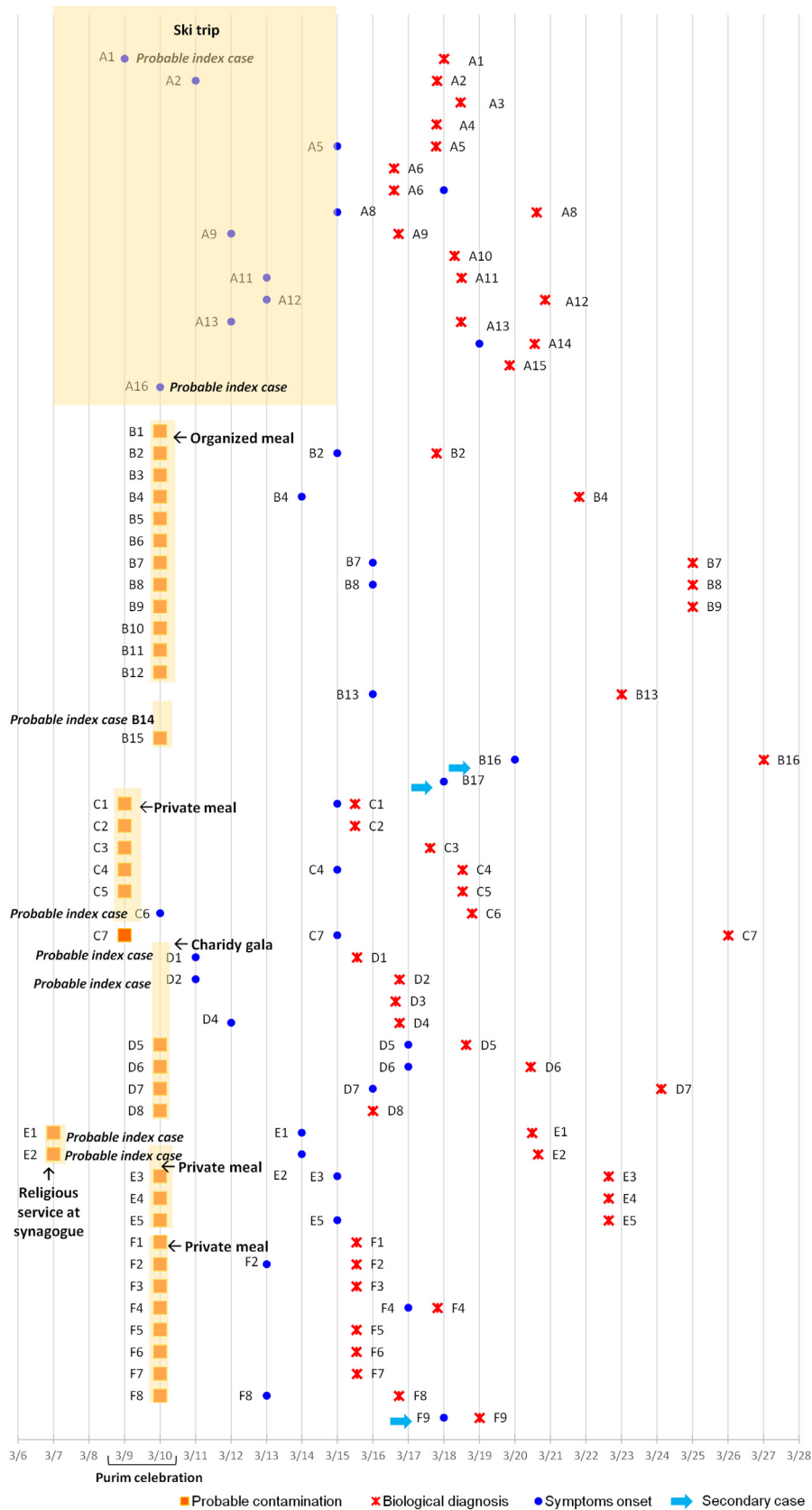
Interestingly, the case B13, which was not present to the meal but household member B14 did, developed febrile cough and diarrhea the 16 March 2020, i.e., in the same time than the participants to the meal. It turned out that B14 had a viral syndrome with anosmia a few days earlier. Temporal clustering suggests that B14 could have been the index case of cluster B.

##### Cluster C: religious service and a Purim meal

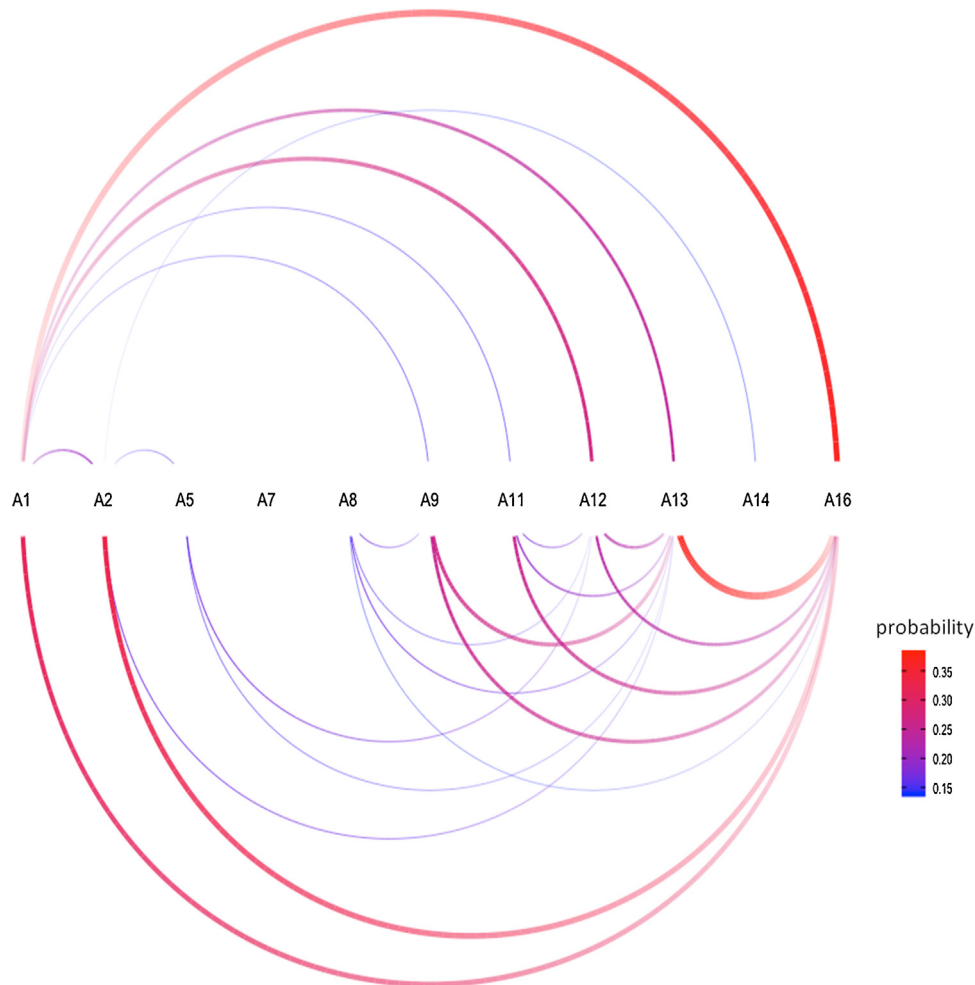
Seven patients, including six adults and one child, with a biological diagnosis confirmed between March 15th and 27th were linked to cluster C (Figure 1). This cluster originated in a synagogue in Marseille on March 10th during a Purim celebration service that gathered approximately 50 people. Afterward, 6 of these patients gathered at a family dinner on the same evening. One of the patients, who was exposed to the virus at work, developed symptoms one day later, suggesting contagiousness at the time of the dinner and making this person the most likely index case. One patient tested positive 8 days later and remained asymptomatic. All the other dinner attendees developed symptoms on March 15th. The 7th case was an individual who visited the same synagogue, developed cough and dyspnea and was hospitalized with oxygen requirements.

##### Cluster D: Charity gala

Cluster D involved 8 patients (7 adults and 1 child) and originated at a charity gala for a Purim celebration dinner on March 10th, which gathered at least 150 people () and lasted at least 4 hours. Six patients attended the gala, and two were household members of two participants. The mean age of the 8 patients was



**Figure 1.** Temporal distribution of cases in the six clusters identified in the Jewish community in Marseille. The clusters are named A to F. In each cluster, each case is affected to a number. Common exposure events are noticed with a yellow background.



**Figure 2.** Possible transmission tree The possible transmission tree is represented as a linear graph where the cases are the nodes, and the possible transmission are the arcs. The transmission direction is shown by the increasing opacity of the arc, and the arc color (from blue to red) reflects the probability of transmission.

49 years. The two index cases of the cluster might have been a couple of attendees that developed symptoms of COVID-19 the day following the gala, suggesting they were probably already contagious at the time of the dinner. Two patients tested positive on March 16th but remained asymptomatic. The two household members, which were not present at the event, were also diagnosed on March 16th.

#### Cluster E: saturday religious service

Cluster E comprised 5 patients (4 adults and 1 child) and was identified in a synagogue of another neighborhood of Marseille. The cluster included a 63-year-old woman and a 62-year-old man (not from the same family) that attended a Saturday religious service on March 7, 2020. They were both diagnosed on March 20th, 7 days after symptom onset. A family gathering for Purim celebration on March 10th probably led to the infection of 3 family members of one of the index cases (. Only one of the four children of the family tested positive but remained asymptomatic, and the PCR test results of the siblings were negative.

#### Cluster F: Purim meal

Cluster F included 9 cases. This cluster originated from a family meal on March 10th for Purim celebration, gathering 17 people and resulting in the infection of at least 9 people (8 adults and 1 child), including a secondary case (. The mean age was 46 years. They all developed symptoms between March 13th and 17th. While

interviewing infected patients, most of them reported that others around them presented with the same symptoms but were not tested. A secondary case, the father of one of the attendees, developed fever and rhinorrhea on March 18th.

#### Global analysis

For the 19 cases for which the incubation period can be calculated, it was of 3 days in two cases, 4 days in one case, 5 days in seven cases, 6 days in three cases, 7 days in four cases, and 8 days in two cases. Interestingly, based on the Bayesian outbreak reconstruction, up to 40% of the patients were infected by index patients during the presymptomatic period, which was 2.5 days before symptoms onset (Li et al., 2020). The remaining proportion of case transmission was distributed on the following 8 days.

Given the considerable spatio-social mixing during the period of Purim celebration, it seemed pertinent to analyze COVID19 attack rates in adults and children. The families for which the PCR testing was performed on all the siblings were taken into account i.e. 32 individuals. The clinical attack rate in adults was 85% compared to 26% in children. The PCR attack rate in adults was 100% compared to 37% in children. The clinical and PCR attack rates in children were significantly lower than in adults that is, 3.3- and 2.7-fold lower for clinical and PCR attack rates, respectively ( $p < 0.005$ ; mid-P exact).



A total of 16 serum / plasma samples were available for serological analyses, collected from 10 to 107 days after biological diagnosis of COVID-19. Anti-SARS CoV2 IgG antibodies were detected in all but two samples. One of them was collected 12 days after biological diagnosis, in a patient who presented fever, anosmia, ageusia, headache, myalgia, and dyspnea. The second serum tested without anti SARS CoV2 IgG antibodies was collected 55 days after the first positive PCR testing in an asymptomatic patient.

## Discussion

Our retrospective investigation allowed the identification of 6 clusters in the Marseille Jewish community. As shown by the temporal and spatial clustering of cases, multiple gateways for the COVID-19 epidemic seemed to concomitantly occur during a short period of 10 days, between March 5th and 15th. Family and religious gatherings for Purim celebration likely favored the rapid spread of SARS-CoV-2 in community settings.

It is well-known that mass gatherings are seeding events to spread outbreaks of communicable diseases (Hoang et al., 2019; Sokhna et al., 2017; Sow et al., 2018).

However, these gatherings usually have several hundreds or thousands of attendees. Indeed, in the context of COVID19 pandemics, a religious meeting of the Christian Open-Door Church held in Mulhouse (Eastern France) from 17th to 24th February 2020, and that gathered about 2000 people from different French regions, was one of the first big clusters described at the beginning of the spreading of the disease in France: the attendings carried the virus back home into their areas of origin (Kuteifan et al., 2020; Torres, 2020). In this study, we demonstrated that smaller scale gatherings could be an essential issue in the SARS-CoV-2 outbreak. Meals shared by several individuals seemed to represent the main common feature of the clusters. As a moment conducive to the discussion, close contact between the participants, moreover, in a confined area, certainly favored the transmission of the virus. Index cases were not found in all clusters.

Clusters of COVID-19 transmission have already been described in travel and community settings in Singapore especially linked to a tour group from China, a company conference, and a religious celebration at a church (Pung et al., 2020). Interactions between clusters in this study may also have played a role in the spread of SARS-CoV-2 in the Marseille Jewish community.

The incubation period ranged from 3 to 8 days

When considering household members and excluding patient Ah, who scrupulously respected distancing measures with other family members who returned from the ski trip (Figure 1), 12 patients that did not develop any relevant clinical symptoms compatible with COVID-19 tested negative. Notably, all 12 of these patients were 1–16 years of age. We found attack rates 3.3 and 2.7 fold lower in children than in adults (for clinical and PCR, respectively). Attack rate estimation is affected mainly by the number of susceptible subjects and the probability of adequate close contact. The bias linked to the second factor is the most reduced because children were in close contact with adults during Purim celebration and most of them were not at school because of holidays. Spatio-temporal and social mixing were at their peak during Purim. Two studies in Shenzhen and Guangzhou, China reported lower average secondary attack rates of 11.2% and 17.1% among household contacts (Bi et al., 2020; Jing et al., 2020). Bi et al reported that children <10 years were as likely to be infected as adults (7.4% in children <10 years vs population average of 6.6%) (Bi et al., 2020). Inversely, Jing et al reported a risk of infection lower in individuals <20 years (attack rate = 5.2%) than in adults aged 20–59 years (14.8%) or >60 years (18.4%) (Jing et al., 2020).

However, in this latter study, physical distancing was not taken into account and the contact pattern may have changed and caused a two-fold reduction of the probability of household transmission between January and February. In our work, the lower attack rate estimation in children is clearly not linked to behavioral compartments and thus suggests a lower susceptibility of children to COVID19. Dattner et al also reported recently the same findings and estimated that the susceptibility of children (<20 years old) was 45% of those of adults (Dattner et al., 2020).

Some limits of our work should be noted. Firstly, the attack rates were estimated in specific conditions: close proximity during attendance wherein participants mostly had a meal at the same table or took part in a religious office in confined areas. Probably, the estimation of attack rates outdoors may be lower. Secondly, a small number of people (32 individuals) are included in this estimation, with the complete data being unavailable for the others. Furthermore, in March 2020, the systematic screening by PCR of all close contacts with an infected case was not recommended in France; thus, some asymptomatic cases may not have been tested and included in the study. Finally, this work was mostly based on patients' reporting, inducing an inevitable memory bias.

Such rapid spread was likely favored by the human density of attendees in the different events that enabled prolonged contacts among participants. The organization of Jewish life, featuring many gatherings and regular social group interactions, including weekly Shabbat services and other social and community events may probably accelerate transmission of the virus in the community setting. Moreover, Purim festival celebrations, which occurred just one week before the French national decision of general population containment, gathered even more people than usual. Unfortunately, public health messages in France warning against small gatherings of people to prevent COVID-19 spread were not released prior to Purim.

## Conclusion

Family and community gatherings for Purim Jewish celebration probably accelerated the spread of COVID-19 in the Marseille Jewish community, leading to multiple epidemic clusters. The investigation of family clusters highlighted that all close contacts with confirmed cases of COVID-19 who were not infected were children and that the attack rate in children was significantly lower than in adults. The results of this study suggest that children may have lower susceptibility to SARS-CoV-2 infection. Further investigations need to be conducted with potential implications for public health measures.

## Author contributions

Conceived and designed the experiments: SA, PG, BL  
 Contributed materials/analysis tools: SA, PG, HC  
 Analyzed the data: SA, PG, HC  
 Wrote the paper: SA, PG, DR, BL

## Funding

This work was supported by the French Government under the "Investments for the Future" program managed by the National Agency for Research (ANR), Méditerranée-Infection 10-IAHU-03 and was also supported by Région Provence-Alpes-Côte d'Azur and European funding Fonds Européen de Développement Régional - Plateformes de Recherche et d'Innovation Mutualisées Méditerranée Infection (FEDER PRIMMI).

## Conflict of interest

The authors have no conflicts of interest to declare. The funding sources had no role in the design or conduct of the study; collection, management, analysis, or interpretation of the data; or preparation, review, or approval of the manuscript.

## Ethics

All data were generated as part of the routine work at Assistance Publique - Hôpitaux de Marseille (Marseille University Hospitals), and the study results were generated from routine standard clinical management. The investigator (SA) informed participants of this survey and obtained their verbal consent.

## Acknowledgments

None.

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