Household SARS-CoV-2 transmission and children: a network prospective study

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Summary: We included 1040 COVID-19 patients <16 years, more than 70% were secondary to an adult, whereas 7.7% were index cases**.** The secondary attack rate was significantly lower in households with COVID-19 pediatric index cases when compared to adults (p=0.006).

Abstract

Background

The role of children in household transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) remains uncertain. Here, we describe the epidemiological and clinical characteristics of children with COVID-19 in Catalonia (Spain) and investigate the dynamics of household transmission.

Methods

Prospective, observational, multicenter study performed during summer and school periods (1 July-31 October, 2020), in which epidemiological and clinical features, and viral transmission dynamics were analyzed in COVID-19 patients <16 years. A pediatric index case was established when a child was the first individual infected within a household. Secondary cases were defined when another household member tested positive for SARS-CoV-2 before the child. The secondary attack rate (SAR) was calculated, and logistic regression was used to assess associations between transmission risk factors and SARS-CoV-2 infections.

Results

The study included 1040 COVID-19 patients <16 years. Almost half (47.2%) were asymptomatic, 10.8% had comorbidities, and 2.6% required hospitalization. No deaths were reported. Viral transmission was common among household members (62.3%). More than 70% (756/1040) of pediatric cases were secondary to an adult, whereas 7.7% (80/1040) were index cases. The SAR was significantly lower in households with COVID-19 pediatric index cases during the school period relative to summer (p=0.02), and when compared to adults (p=0.006). No individual or environmental risk factors associated with the SAR were identified.

Conclusions

Children are unlikely to cause household COVID-19 clusters or be major drivers of the pandemic even if attending school. Interventions aimed at children are expected to have a small impact on reducing SARS-CoV-2 transmission.

Keywords: coronavirus; SARS-CoV-2; child; household; transmission.

Introduction

The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has led to a global public health crisis. It is essential to understand the dynamics of SARS-CoV-2 transmission to plan effective infection control, and spread of the virus within households is known to be high.[1–3] The precise role of children in transmitting this novel coronavirus is uncertain, but it is now evident that strict measures to control the pandemic can be detrimental to a child's health and well-being.[4]

Children seem to be largely spared from the direct health effects of COVID-19. Generally they have milder disease[5] and may be less susceptible to infection.[6,7] Data from several countries[5,8] have shown that children do not amplify transmission within households, schools, or the community[9,10]. However, these studies were mainly performed during the first wave of the coronavirus disease 2019 (COVID-19) pandemic, when strict lockdown measures including school closure were adopted by most countries; hence, the results could somehow be biased.[11–14] One such example is our retrospective pilot study of all COVID-19 pediatric cases in Catalonia (Spain) that occurred during the first lockdown (10 March-31 May, 2020).[15] We found that children played a small role in viral transmission among household members, but these results should be confirmed in a prospective design.

A much larger percentage of children than adults with COVID-19 are asymptomatic, and this has been proposed as a reason for their minor role in viral shedding. In a study from Wuhan (China), no secondary infections were detected among 1174 close contacts with asymptomatic pediatric cases.[16] Nonetheless, studies based on SARS-CoV-2 viral load in respiratory samples suggest that children could potentially transmit the virus in the same way as adults, even when asymptomatic.[17,18] Therefore, more data are needed to better define the contribution of children to SARS-CoV-2 transmission, so that an appropriate course of action can be designed for this age group.

On 13 March 2020, 5492 Catalonian schools with 1,565,478 students were closed in an effort to contain the spread of COVID-19.[19] Soon after, the "COVID-19 Pediatric Disease in Catalonia" (COPEDI-CAT) project was launched to assess the contribution of children to transmitting the virus. In this study, our aim was to describe the epidemiological and clinical characteristics of pediatric COVID-19 cases in Catalonia and investigate the dynamics and potential role of children in household transmission during the summer break and after school initiation.

Methods

Study design

This is a prospective, observational, multicenter study. Between 1 July and 31 October, 2020, data were collected from COVID-19 patients <16 years of age. Patients were diagnosed in the participating centers by reverse transcription polymerase chain reaction (RT-PCR) or rapid antigen testing (PANBIO COVID-19 Ag rapid test device, Abbott). In the primary care setting in Catalonia, children are followed by a pediatrician up to the age of 16 years; hence, this age was set as the upper limit for inclusion. We followed the STROBE statement for observational studies.[20] Two study periods were established, *summer time* (1 July-15 September) and *school time* (16 September-31 October), based on the markedly different epidemiological background before and after schools reopened. Nonpharmaceutical interventions were applied in all schools, including face masks in classrooms and school buildings in children older than 6 years.

Data sources and setting

Catalonia, an autonomous region in northeast Spain with 7.5 million inhabitants (1,581,341 younger than 20 years), has a universal, publicly-funded health system with 7 sub-regional departments and more than 400 primary health care centers.

Within the COPEDI-CAT project, more than 120 pediatricians from 71 primary health centers and public and private hospitals recorded the demographic, epidemiologic, clinical, and diagnostic data of pediatric COVID-19 cases. Information on the total and positive SARS-CoV-2 RT-PCR results related to eligible participants was delivered by the Catalan Agency for Quality and Health Assessment (AQuAS), which obtained the data from the Catalan Epidemiological Surveillance Network and the referral microbiological laboratories.[21]

A questionnaire was designed and distributed to all participating pediatricians to collect clinical and microbiological information related to pediatric COVID-19 cases and their household contacts (**Supplemental data**).

Study definitions

A confirmed COVID-19 case was defined as any individual testing SARS-CoV-2 positive by real-time RT-PCR or by antigen testing in a respiratory specimen. Viral antigen testing was only available during the last week of the study period (26-31 October, 2020). To avoid selection bias in case recruitment, pediatricians recorded all positive cases seen in daily practice. However, during work overload peaks, they only collected data from the first 5 positive cases per day. Contact tracing for each COVID-19 patient <16 years was done by the COPEDI-CAT group. Household contacts were defined as all persons living in the same household as the first patient diagnosed, regardless of the duration or proximity of the contact. Follow-up was performed by the patient’s pediatrician during a primary care visit, or by telephone interview with parents or legal guardians, using the dedicated questionnaire. All data were recorded in a web-based platform, Research Electronic Data Capture (REDCap®) database.

A pediatric index case was established when a child was the first infected member in the household. The chronology of symptoms and the SARS-CoV-2 RT-PCR test date in contacts were considered surrogates that would reflect transmission dynamics. A secondary case was defined as a symptomatic household contact testing RT-PCR-positive for SARS-CoV-2 before the child. A primary case was established when no household contacts tested SARS-CoV-2 RT-PCR-positive other than the child or when infection temporality could not be established in positive contacts. In asymptomatic patients, onset was defined as the date of specimen collection for the first positive RT-PCR.

Statistical analysis

A descriptive analysis was performed in pediatric and adult cases identified during the two study periods. Bivariate tests (chi-square and independent sample t tests) were used to assess differences in sociodemographic, household, and clinical characteristics between summer and school periods in index and secondary cases. The secondary attack rate (SAR) was calculated by dividing the total number of household contacts by the number of new SARS-CoV-2 infections among contacts. Univariate and multivariate logistic regression analyses were used to assess associations between transmission risk factors and SARS-CoV-2 infection in pediatric and adult index cases. For the multivariate generalized regression analysis, we selected variables representative of different potential modes of SARS-CoV-2 transmission, those that had a greater effect size on univariate analysis, and those that were significant ($p<0.05$). All models were adjusted for sex, age, number of household contacts, and whether or not index cases were symptomatic.

Ethical considerations

Ethical approval was obtained from the referral IDIAP-J. Gol Research Foundation for Primary Care in Catalonia, Spain (20/187-PCV), and the coordinating center of the study, Vall d'Hebron Research Institute, Barcelona, Spain (PR(AG)475/2020).

Results

In the overall study period, 26,665 of 417,578 (6.4%) SARS-CoV-2 RT-PCRs in individuals younger than 16 years tested positive.

We initially recruited 1309/26,665 (4.9%) COVID-19 pediatric patients. Ultimately, 1040 patients aged <16 years with complete clinical, epidemiological, and microbiological data were included (**Figure 1**): 547 during summer (1 July-15 September) and 493 after schools reopened (16 September-31 October). The clinical and epidemiological data (**Table 1)** showed no significant differences in sex, but both study periods had a higher percentage of patients aged 6 to 12 years (358/1040, 34.4%). The analysis found a median [IQR] of 3 [2-4] household contacts, a living area of 90 [70-110] m^2 with 3 [3-4] rooms, and smokers in 20.8% (197/947) of households (**Table 1**).

Nearly half the pediatric cases (491/1040; 47.2%) were asymptomatic, with a higher rate during the school than summer period (51.7% vs 43.1%; p=0.006). Most symptomatic cases (549/1040; 52.8%) had mild symptoms (**Table 2**). Overall, 10.8% (111/1028, information missing in 12) had some type of comorbidity, 27 children (2.6%) required hospitalization, there were no deaths, and 6 children had mainly minor sequelae: persistent fever (2), anosmia, ageusia, aphonia, and prolonged positive RT-PCR together with mesenteric lymphadenitis. Pediatric index cases were more commonly symptomatic than secondary cases (83.7% vs 47.1%; p<0.001) during both periods (**Table 3**). Differences in median number of household contacts between index and secondary cases were attributable to the different ranges in the two groups. Otherwise, no differences regarding sex, age range, living area (m^2), presence of smokers in the household, or hospitalization requirement were found between index and secondary cases. Of note, only 5 children with comorbidities (3 preterm babies, 1 neurological abnormality, and 1 sickle cell disease and cancer) were hospitalized. There were no differences regarding the presence of symptoms or hospitalization requirement between these patients and children without comorbidities.

According to the pediatric COVID-19 case classification used, 72.7% (756/1040) of children were cases secondary to an adult case, and 5.0% (52/1040) were secondary to another child. Only 7.7% (80/1040) of children included were household index cases. The remaining 14.6% (152/1040) were primary cases; 109 (71.7%) did not transmitted the infection to any of the household contacts, and we were unable to determine the directionality of the transmission in 43 (28.3%) of them. Even when schools were open, pediatric cases were much more likely to be secondary cases from household transmission rather than index cases (**Table 3**).

In total, 3392 household contacts were linked to the 1040 pediatric cases. Epidemiologic and clinical features are shown in **Table 4**. Age, family member relationships, and percentage of positive SARS-CoV-2 RT-PCRs per household according to age of the pediatric case differed significantly between summer and school periods. The median [IQR] of SARS-CoV-2 infections per household was 62.3% [33.3%-100.0%] with no differences between the periods. The SAR for SARS-CoV-2 infection was significantly lower in households with pediatric index cases than those with adult index cases (59.0% vs 67.6%; p=0.006) (**Figure 2 and Table 5**). No individual or environmental risk factors for an increased SAR were detected in pediatric index cases**.** Of note, the SAR was significantly lower during the school period in this group (53.0% vs 64.4%; p=0.02). When index case was younger than 3 years of age, SAR was significantly lower during the school period than in summer time (62.1% vs 33.3%; p=0.02). We did not find any other significant differences between school and summer time for other age-group index cases. When the index case was an adult, the SAR was significantly higher among female or non-adult household contacts, and when family size was ≤4 members **(Table 5)**. In households with an adult index, the SAR was almost identical in the summer and school periods, (67.7% vs 67.5%, respectively).

Among the 80 pediatric index cases, 14 of them did not transmit the infection to any of the household contacts. On the contrary, among adult index cases, all of them infected at least someone else at home.

Discussion

The contribution of children to spreading SARS-CoV-2 has been debated since early days of the pandemic. In this study, we assessed the clinical and epidemiological characteristics, and determined viral transmission dynamics of 1040 pediatric COVID-19 cases linked to 3392 household contacts.

Most children <16 years had mild disease: nearly half were asymptomatic (47.2%) and very few needed hospital admission (2.6%). Children were tested as a part of the contact tracing studies within the household but also due to mass screening studies performed in the schools. In fact, asymptomatic cases were higher when the schools were open (51.7%) than in summer time (43.1%) (p=0.006) likely as a result of these mass screening studies (**Table 2**). Within their households, most pediatric COVID-19 cases were secondary to an adult case (72.7%), and most importantly, only 7.7% of children were drivers of SARS-CoV-2 infection. COVID-19 disease spreads easily among household members; 6 of every 10 contacts tested RT-PCR positive, but very few (2.4%) required hospitalization. The SAR was significantly lower in households where children rather than adults had transmitted SARS-CoV-2 (p=0.006), and it was even lower during the school period, when children were expected to be more contagious because of social interaction with classmates.

The household SAR we found (62.3%) is significantly higher than values reported in studies from China (11.2%),[22] Korea (11.8%),[2] and the United States (29.0%),[23] but it is within the range found in two meta-analyses (4.6% to 90%).[24,25] On stratification by age in available household studies, children were seldom the index cases (4%-8%),[11,26] a finding similar to our results (7.7%), but higher than a recent published study performed in the first wave[27]. These differences may be due to different epidemiological scenarios, with a very limited childhood interactions in stronger lockdowns.

A recent systematic review concluded that children and adolescents are less susceptible to SARS-CoV-2 infection than adults, with the lowest risk in the 10 to 14 year-old group.[6] However, in the present study, the SAR was significantly higher in transmission from adult index cases to child household contacts than from adults to adult contacts ($p<0.001$). This discordant finding may be attributable to the study focus on pediatric cases, with possible underestimation of the adulthood SAR.

In contrast to previous assumptions that asymptomatic COVID-19 in children is associated with silent transmission[17] or that asymptomatic index cases are associated with a lower SAR,[1,16] we found no differences in the SAR between symptomatic and asymptomatic index cases either in children or adults, even though nearly half the children included were asymptomatic. Asymptomatic pediatric cases were significantly higher during the school than summer period, likely because of generalized screening performed in schools ($p=0.006$).

Regarding the clinical features of COVID-19, the most common symptoms described in European adults have been headache (70.3%), loss of smell (70.2%), and nasal obstruction (67.8%),[28] which contrasts with the fever (58.3%), cough (47.3%) and sore throat (18.3%) in children[29] (similar to our data). As reported, few affected children have an underlying pathology (14%-25%, mainly chronic lung disease and cardiovascular disease),[15,29,30] and only 2.5%-4.1% require hospitalization.[30] Again, our data support these findings: few children had comorbidities and there were no differences regarding symptoms and hospitalization rates between those with and without comorbidities. These data reinforce the idea that no special SARS-CoV-2 preventive measures are needed for children with underlying diseases.

Overcrowding appears to be determinant in SARS-CoV2 dissemination,[31] but the risk of secondary cases was not higher in households with a larger number of members or smaller living area. Socioeconomic status was not recorded here; further research is needed to address the effect of poverty on pediatric SARS-CoV2 transmission.

In Catalonia, schools were closed on 13 March, two days after the pandemic was officially declared, to decrease SARS-CoV2 community transmission.[19] Most schools did not reopen until September, 2020. During the summer, some sectors of our society discussed whether closing schools was the right decision, as data were emerging of low transmissibility in children.[32,33] Some countries such as Taiwan were able to minimize SARS-CoV2 spread without complete school closure.[34] COVID-19 modeling studies have predicted that school closure alone would prevent 2%-4% of deaths, a rate far from that achieved with other social distancing interventions.[35] Nonetheless, other studies investigating nonpharmaceutical interventions to reduce COVID-19 highlight school closure as a major option to consider.[36,37] However, this radical measure can have adverse consequences[38]. Closing schools interrupts learning and can lead to poor nutrition, stress, and social isolation in children.[36] Disruption of education has a significant negative impact on society as a whole and on children's health and well-being, potentially leading to inequity issues and a loss of years of life.[4]

Official data from the three months after school reopening in Catalonia are reassuring, as viral transmission was low in schoolmates and teachers.[39] Our data confirm a milder disease course in children and show that their contribution to transmission is low during the school period even in the high-risk household environment, where (in contrast to the norm in schools) no preventive measures are adopted. These findings support the safety of maintaining schools open, as proposed by the European Centre for Disease Prevention and Control[40] and the American Academy of Pediatrics in its last interim report on 5 January, 2021.[41]

The prospective design, large sample, and collaborative network of pediatricians from primary health centers and hospitals add value to this study. These physicians, who recorded household cases and contact data, knew all the families included; hence, the final case classification is likely more accurate than if it had been done by external researchers.

Nonetheless, the study has limitations. First, numerous pediatricians within COPEDI-CAT registered the data simultaneously, and even with standardized recording, data entry errors can occur. We addressed this issue by ongoing double-checking, and deep review of all data before analysis. Second, information on older children was limited, as primary care pediatricians only attend children aged <16 years. Adolescents 16 to 18 years, who may have a major role in viral transmission, were not included. Third, the index case in each cluster was defined as the person in the household who first developed symptoms or first tested RT-PCR SARS-CoV-2 positive. Therefore, the contribution of asymptomatic individuals to transmission may have been underestimated. And finally, these findings are specific to the variant distribution at the time of the study, and could be different if the new SARS-CoV-2 variants shift their distribution in the future.

Conclusions

SARS-CoV-2 transmission is high among household members, but most children and young adolescents are mildly affected. Our results show that children, whether symptomatic or not, do not greatly contribute to household clusters of infection and are unlikely to be major drivers of the pandemic even when schools are open. Interventions aimed at children are expected to have a small impact on reducing COVID-19 and should be optimized to exclude overly stringent measures that can profoundly affect the well-being of this population.

NOTES

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Table 1. Main clinical and epidemiological data of study participants by study period

	Total, n=1040		Summer period, n=547		School period, n=493	
	median, n	IQR, %	median, n	IQR, %	median, n	IQR, %
Sex						
Male	529	50.9	278	50.8	251	50.9
Female	511	49.1	269	49.2	242	49.1
Age, y						
0 to <3	223	21.4	136	24.9	87	17.7
3 to <6	181	17.4	106	19.4	75	15.2
6 to <12	358	34.4	174	31.8	184	37.3
12 to <16	278	26.7	131	23.9	147	29.8
Household contacts	3	2-4	3	2-4	3	2-4
Living area (m^2)	90	70-110	90	75-110	90	70-110
Rooms, n	3	3-4	3	3-4	3	3-4
Smokers in household, yes	197	18.9	109	19.9	88	17.8
Symptoms,* yes	549	52.8	311	56.9	238	48.3
Admitted to hospital, yes	27	2.6	17	3.1	10	2.0
Final outcome						
Sequelae	6	0.6	4	0.7	2	0.4
Comorbidities, yes	111	10.7	52	9.5	59	12.0
Case classification						
Index	80	7.7	39	7.1	41	8.3
Primary	152	14.6	73	13.3	79	16.0
Secondary to adult	756	72.7	414	75.7	342	69.4
Secondary to another child	52	5.0	21	3.8	31	6.3

*p-value for symptoms was significantly different (0.006) between summer and school periods

Table 2. Clinical features of patients by study period

Signs and symptoms in children with COVID-19 (1 July to 31 October, 2020)				
	Total N=1040	Summer period N=547	School period N=493	p-value
Signs/symptoms	**N (%)**	**N (%)**	**N (%)**	
Asymptomatic	491 (47.2%)	236 (43.1%)	255 (51.7%)	**0.006**
Symptomatic	549 (52.8%)	311 (56.9%)	238 (48.3%)	
Fever	395 (71.9%)	236 (75.6%)	159 (66.5%)	0.017
Cough	206 (37.4%)	91 (29.2%)	115 (48.1%)	<0.001
Headache	130 (23.6%)	64 (20.5%)	66 (27.6%)	0.073
Fatigue	128 (23.2%)	60 (19.2%)	68 (28.4%)	0.018
Diarrhea	91 (16.5%)	56 (18.0%)	35 (14.6%)	0.233
Abdominal pain	72 (13.1%)	44 (14.1%)	28 (5.7%)	0.277
Vomiting	53 (9.6%)	29 (9.3%)	24 (11.7%)	0.048
Ageusia/Anosmia	45 (8.2%)	28 (9.0%)	17 (7.1%)	0.524
Skin lesions	27 (4.9%)	19 (6.1%)	8 (3.3%)	0.999
Dyspnea	26 (4.7%)	9 (2.9%)	17 (7.1%)	0.036
Others	135 (24.5%)	86 (27.6%)	49 (20.5%)	0.071

Table 3. Epidemiologic characteristics of pediatric index and secondary cases during the two study periods

	Total		Summer period		School period	
	Index cases (n=80) (n/%)	Secondary cases (n=756) (n/%)	Index cases (n=39) (n/%)	Secondary cases (n=414) (n/%)	Index cases (n=41) (n/%)	Secondary cases (n=342) (n/%)
Sex						
Male	36/45.0	385/50.9	19	205	17	180
Female	44/55.0	371/49.1	20	209	24	162
Age, y						
0 to <3	15/18.7	155/20.5	11/28.2	95/23.0	4/9.7	60/17.5
3 to <6	14/17.5	136/18.0	7/17.9	85/20.5	7/17.1	51/14.9
6 to <12	27/33.8	261/34.5	12/30.8	132/31.9	15/36.6	129/37.7
12 to <16	24/30.0	204/27.0	9/23.1	102/24.6	15/36.6	102/29.8
Household contacts, median/IQR	3/2-4	3/2-4	3/3-4.5	3/2-4	3/2-4	3/2-4
Living area, m^2, median/IQR	80/70-100	90/70-110	79/65.3-97.5	90/75-110	87.5/75-100	87/70-110
Rooms, n, median/IQR	3/3-4	3/3-4	3/3-3	3/3-4	3/3-4	3/3-4
Smokers in household, yes	20/25.0	139/18.4	13/33.3	76/18.4	7/17.1	63/18.4
Symptoms, yes	67/83.7	356/47.1	36/92.3	204/49.3	31/75.6	152/44.4
Hospital admission, yes	4/5.0	15/2.0	4/10.3	8/1.9	0/0.0	7/2.0
Final outcome						
Sequelae	3/3.8	3/0.4	1/2.6	3/0.7	2/4.9	0/0.0
Comorbidities, yes	12/15.0	71/9.4	5/12.8	37/8.9	7/17.1	34/9.9

Table 4. Baseline characteristics of household contacts of children with COVID-19

	Total (n=3392)		Summer period (n=1766)		School period (n=1626)	
	N	%	n	%	n	%
Sex						
Male	1641	48.4	840	47.6	801	49.3
Female	1750	51.6	925	52.4	825	50.7
Age, y, median/IQR)	34	13-43	34	14-43	35	13-44
Family relationship						
Father	837	24.7	427	24.2	410	25.2
Mother	961	28.3	495	28.0	466	28.7
Sister/brother	1139	33.6	549	31.1	590	36.3
Grandparents	158	4.6	102	5.8	56	3.4
Others	288	8.5	188	10.6	100	6.2
Missing	9	0.3	5	0.3	4	0.2
Symptoms, yes	1386	40.9	773	43.8	613	37.7
Total positive PCRs among household contacts	2091	61.6	1100	62.3	991	60.9
Positive PCRs by household, median (IQR)	62.3	(33.3-100.0)	63.5	(33.3-100.0)	60.9	(33.3-100.0)
Positive PCRs by household and age of pediatric case, y						
0 to <3	449	21.5	269	24.4	180	18.2
3 to <6	395	18.9	240	21.8	155	15.6
6 to <12	720	34.4	355	32.3	365	36.8
12 to <16	527	25.2	236	21.5	291	29.4
Hospital admission, yes	80	2.4	48	2.7	32	2.0
ICU admission among hospitalizations, yes	3	3.7	1	2.1	2	6.2

Table 5. Secondary attack rates and household risk factors for SARS-CoV-2 infection between paediatric and adult index cases

Pediatric index case	Infected cases, N	Total contacts, N	Secondary attack rates, %	OR (95% CI)	p-value
General transmission rate*	167	283	**59.0**		
Contact sex					
Female	94	150	62.7	1.71 (0.81-3.59)	0.16
Male	73	133	54.9	Ref.	-
Contact age					
< 18 y	60	100	60.0	Ref.	-
≥ 18 y	107	183	58.5	0.56 (0.21-1.49)	0.246
18-39 y	49	84	58.3		
40-65 y	56	97	57.7		
≥ 65 y	2	2	100		
Index case sex					
Female	89	155	57.4	0.77 (0.39-1.49)	0.432
Male	78	128	60.9	Ref.	-
Pediatric index case age					
0 to <3 y	39	53	73.6	2.27 (0.62-8.35)	0.216
3 to <6 y	24	47	51.1	0.88 (0.39-1.98)	0.75
6 to <12 y	59	101	58.4	1.18 (0.53-2.65)	0.687
12 to <16 y	45	82	54.9	Ref	-
Index case symptoms					
Yes	150	247	60.7	1.72 (0.65-4.52)	0.276
No	17	36	47.2	Ref.	-
Family size					
4 or fewer	67	116	57.8	0.89 (0.45-1.77)	0.739
More than 4	100	167	59.9	Ref.	-
Relationship	48	76	63.2	Ref.	-

Mother	38	65	58.5	1.44 (0.6-3.47)	0.418
Father	62	108	57.4	0.58 (0.2-1.63)	0.298
Sister/brother	2	5	40.0	0.34 (0.06-2.03)	0.239
Grandparents	17	29	58.6	0.88(0.33-2.40)	0.809
Other					

Adult index case	**Infected cases, N**	**Total contacts, N**	**Secondary Attack Rates, %**	**OR (95% CI)**	**p-value**
General transmission rate*	393	581	**67.6**		
Contact Sex					
Female	219	304	72	**1.71 (1.13-2.57)**	**0.01**
Male	174	277	62.8	Ref.	-
Contact age					
<18 y	271	340	79.7	Ref.	-
≥18 y	122	241	50.6	**0.24 (0.17-0.35)**	**<0.001**
18-39 y	65	121	53.7		
40-65 y	49	103	47.6		
≥65 y	8	17	47.1		
Index case sex					
Female	192	299	64.2	0.81 (0.51-1.29)	0.374
Male	201	282	71.3	Ref.	-
Case age					
18-39 y	207	304	68.1	Ref.	-
40-65 y	183	272	67.3	0.89 (0.56-1.42)	0.629
≥65 y	3	5	60	1.44 (0.85-2.43)	0.177
Index case symptoms					
Yes	382	565	67.6	0.75 (0.14-4.07)	0.738
No	11	16	68.8	Ref.	-
Family size					

4 or less	218	296	73.6	**1.59 (1.02-2.49)**	**0.04**
More than 4	175	285	61.4	Ref.	-
Relationship					
Partner	88	164	53.7	Ref.	-
Children	270	343	78.7	0.81 (0.34-1.96)	0.645
Parents/parents in law	14	26	53.8	1.76 (0.36-8.72)	0.488
Other	21	48	43.8	0.44 (0.19-1.04)	0.061

***p-value=0.006 in the comparison of secondary attack rate between pediatric and adult index cases**

Figure legends

Figure 1. Study inclusions flow-chart.

Figure 2. Percentage of positive SARS-CoV-2 RT-PCRs in households by the age (pediatric versus adult) of the index cases.

Figure 1

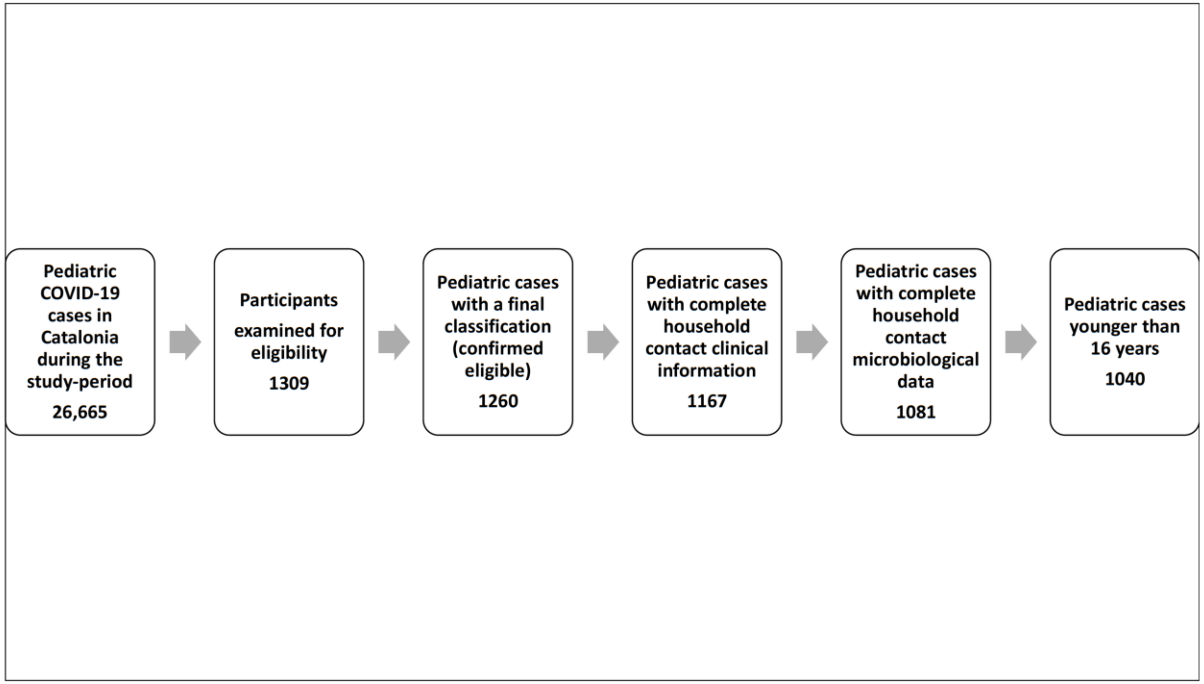
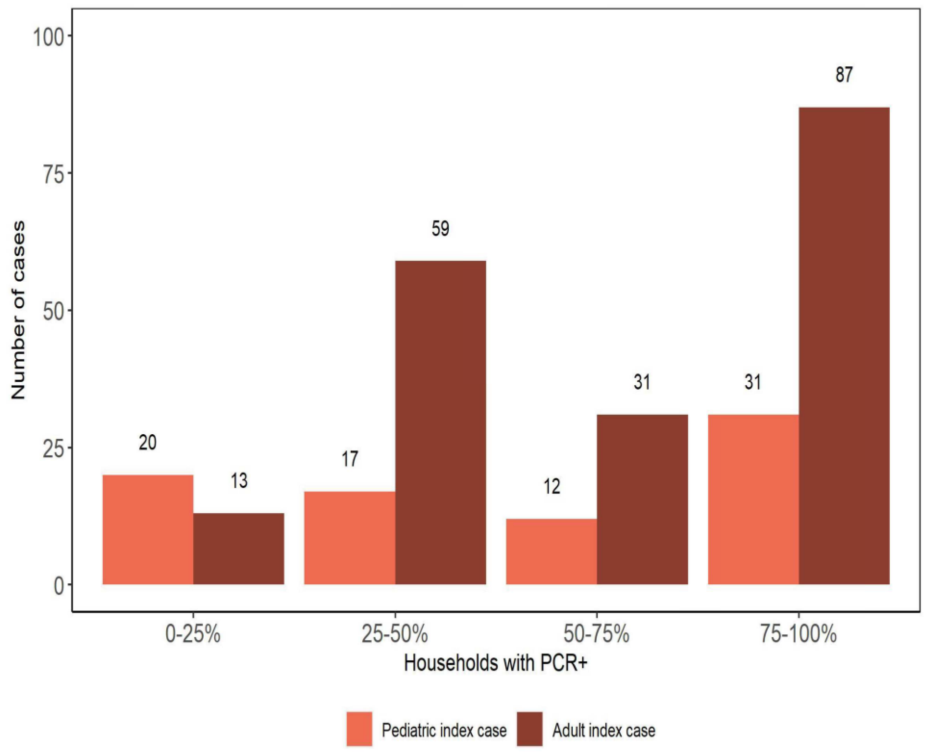

Pediatric COVID-19 cases in Catalonia during the study-period
26,665
Participants examined for eligibility
1309
Pediatric cases with a final classification (confirmed eligible)
1260
Pediatric cases with complete household contact clinical information
1167
Pediatric cases with complete household contact microbiological data
1081
Pediatric cases younger than 16 years
1040

Figure 2



100
75
50
25
0
Number of cases
20
13
17
59
12
31
31
87
0-25%
25-50%
50-75%
75-100%
Households with PCR+
Pediatric index case
Adult index case