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# Investigating COVID-19 Cases in the Health District of Touba, Senegal, March 10 to May 10, 2020: Factors Associated with the Infection

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***Keywords:*** COVID-19; Associated factors; Market; Senegal.

## Abstract

**Background**: The coronavirus pandemic continues to spread around the world. In Senegal, the number of cases continues to increase. The objective of this study was to identify the factors associated with COVID-19 in the health district of Touba.

**Methods:** This was an analytical cross-sectional study. Data were collected using investigation sheets, by individual interviews with suspected cases and contacts who were tested for COVID-19 between March 10 and May 10, 2020. Logistic regression was used to identify associated factors.

**Results:** Out of a total of 554 cases, 232 (41.88%) tested positive for COVID-19 with a median age of 29 years (14 days-100 years). Among the positives, 130 (56.03%) were men, for a sex ratio (M/F) of 1.3. Factors independently associated with COVID-19 were Ocass market attendance (ORa=4.35; 95% CI =[2.38-7.94], p <0.001), urban versus rural residence (ORa =2.77; 95% CI =[1.39-5.53], p=0.005), contact with a positive case (ORa =3.05; 95% CI =[2.13-4.35], p <0.001), participation at a ceremony (ORa=2.40; 95% CI=[1.03-5.59], p <0.001).

**Conclusions:** Attendance at the Ocass market in Touba, attendance at public places, urban setting, contact and participation at a ceremony were all associated with COVID-19. As the pandemic continues to spread, it is crucial to maintain preventive measures and put in place a good community approach to curb its spread.

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## Background

Coronavirus disease 2019 (COVID-19) is an emerging disease that has become a major global public health problem [1]. Globally, as of April 20, 2020, 2,313,455 confirmed cases of COVID-19, including 162,264 deaths, have been reported by the World Health Organization (WHO) [2].

In West Africa, on the same date, 5,548 confirmed cases including 141 deaths, were reported to the West African Health Organization (WAHO) [3].

In Senegal the 1st confirmed case was recorded on 03/02/2020, when a French national tested positive for COVID-19 after contracting the virus in Italy. This first case was followed by three other confirmed cases, also imported from Western countries. The first confirmed case of a Senegalese national was one who lived in Italy and had returned to Senegal precisely in Touba for an annual pilgrimage. This case led to community transmission and, as of March 20, 2020, a group of his contacts now had 23 confirmed cases [4].

The COVID-19 pandemic has led to the implementation of public health measures across the world. The traditional public health epidemic response strategy of isolation, quarantine, social distancing and community containment has been implemented in several countries and has played an important role in preventing further outbreaks [5]. However, these public health measures face a problem of applicability given the precariousness of the informal economy.

Numerous studies have described the epidemiological and clinical characteristics of those diagnosed and factors associated with the severity or death of COVID-19, including advanced age, male gender, cardiovascular disease, hypertension and diabetes [6,7]. However, most research to date has been conducted in patients admitted to hospital with COVID-19, which means that factors associated with COVID-19 in the general population cannot be directly identified. Using investigative data could help identify risk factors for COVID-19 to take the most appropriate public health measures in order to contain the spread of the disease [8,9].

Thus, we conducted this study in order to describe the epidemiological and clinical characteristics and to identify the factors associated with COVID-19 in Touba.

Knowledge of the epidemiological and clinical characteristics of an emerging infectious disease is key to effective outbreak control. Hence, we decided to study the factors associated with COVID-19 in the health district of Touba, from March 10 to May 10, 2020.

## Methods

### Study setting

Touba health district is located in the Diourbel medical region. The Diourbel region is in central Senegal. The district is bordered to the north by the Darou Mousty Health District (DS) to the east by the Linguère Health District to the south and to the west by the Mbacké Health District (Figure 2). With the dashing urbanization of the city of Touba, the city of Mbacké tends to be "phagocytized" by that of Touba. The district covers an area of 553 km². The population of the district is estimated at 878,596 inhabitants in 2019 [10]. Some villages are attached to the Touba district extending its area of responsibility and its target population.

The community of Touba is entirely Muslim and the members are followers of the founder of Mouridism whose representative is the Caliph general of the Mourides. Population movements towards Touba are of such magnitude that there is a semi-rural area made up of new dwellings next to the urban area. It is in these localities that the problems are most acute (water, electricity, health infrastructure).

Trade is the main activity because of the resources that this sector mobilizes. There are retailers to large wholesalers who are suppliers to the surrounding villages and towns. The main market of the city, Ocass, concentrates everything that is business, between pharmacies, hardware stores, cosmetics, generalists. Officially extending over a little less than 300 m by 80 m and located at the crossroads of two main axes, one coming from Mbacké and the other opening onto the road to Dahra, the Ocass Market has become, over time, the place that centralizes all business in Touba.

The city of Touba has an annual pilgrimage that sees up to two million pilgrims from all corners of the globe. Touba also regularly hosts Friday prayers when people from Dakar come to pray and return home. Therefore, Touba remains an area of great concern as returning pilgrims could potentially transmit the virus to the capital as well as to other regions.

### Type of study and period

This was a cross-sectional observational epidemiological study with an analytical aim covering the period from March 10 to May 10, 2020.

### Study population

The study population was the entire population of the Touba Health District.

### Inclusion criteria

Any subject who received a COVID-19 sample in the District of Touba between March 10 and May 10, 2020

### Non-inclusion criteria

Any subject who had a COVD-19 sample taken outside the Touba Health District and any subject who did not consent to participate in the study was not included.

### Case definitions

**Suspected case:** A patient with an acute respiratory illness (fever or history of fever and / or at least one respiratory sign / symptom (Ex: sore throat, cough, shortness of breath), and having no other etiology that fully explains the clinical picture and a history of travel or residence in a country, area or territory reporting local transmission of COVID-19 in the 14 days prior to the onset of symptoms.

**Confirmed case:** A person who tests positive for the COVID-19 specific viral genome by qRT-PCR regardless of clinical signs and symptoms.

**Contact:** Anyone who has had contact (within a radius of less than one meter) with a confirmed case during their symptomatic period and / or four days before the onset of symptoms.

### Sampling

This was an exhaustive sampling of all subjects who had a COVID-19 sample in the District of Touba between March 10

and May 10, 2020.

**Collection technique and tools**

The techniques used were interviews with cases, relatives, contacts, health workers and document review of consultation records.

Data were collected on COVID-19 case investigation forms and confirmed case contact census forms.

**Data collection**

For data collection, service providers from public, semi-public and private facilities were trained for one day. Each time a suspected case was detected, the provider collected data by interviewing with the case, his relatives or family on the suspected case investigation form and and took a nasal and/or oropharyngeal swab sample which was immediately sent to the laboratory. For each confirmed case, an investigation team visited the home to identify contacts meeting the case definition. Nasal and/or oropharyngeal swabs samples were also taken from these contacts. Active searches were conducted to identify and search for suspected cases and contacts.

The data collected included socio-demographic characteristics (age, sex, occupation, place of residence (rural, urban), address with GPS coordinates), detection (date of detection, date of sampling, date of results), history and outcome of illness (date of onset of symptoms/signs, signs/symptoms, level of severity, outcome of illness), exposure (contact with a confirmed case, participation in a ceremony, attendance at markets, attendance at establishments open to the public (hospital, bank, etc.)) and laboratory results.

These data were classified into dependent variable (COVID-19: yes/no) and independent variables (age groups, sex, place of residence, contact with a confirmed case, participation in a ceremony, attendance at markets, attendance at establishments open to the public).

**Definition of some variables**

**- Place of residence**: Is defined as urban according to whether the subject lives in the districts of the city of Touba or rural according to whether he/she lives in the villages of Touba.

**- Ocass market**: Attendance at the Ocass market was defined as any case subject working at the Ocass market or having visited it during the 14 days preceding the date of onset of symptoms or sampling.

**- Ceremony**: Participation in a ceremony was defined as any subject having participated in a baptism, wedding, bereavement, or religious singing, during the 14 days preceding the date of onset of symptoms or sampling.

**- Public facility**: Attendance at an establishment open to the public was defined as any subject having attended a bank or financial institution, a public or private facility, or a health care facility during the 14 days preceding the date of onset of symptoms or collection.

The COVID-19 epidemic in Touba consisted of one (1) primary patient who was infected in a foreign country and several primary patients for whom the source of infection is not known. The primary case means the patient initially detected in the first epidemic cluster. Secondary cases were estimated to be infected by primary cases, tertiary cases were infected by secondary cases, and quaternary cases were estimated infected by tertiary cases.

**Statistical analyses**

**Descriptive analyses**

The collected data were entered into Excel 2016. These data was then exported into Epi Info version 7.2.2.6 and R Studio 4.0.2 for cleaning, coding and data analysis.

Epidemiological and clinical characteristics of cases were described. Quantitative variables were described as mean with standard deviations or median with extremes. Qualitative variables were described as proportions with 95% CI.

Case fatality rate was the number of confirmed deaths (numerator) divided by the total number of confirmed cases (denominator), expressed as a percentage.

The source of infection was summarized on a pie chart and described according to whether the case was imported (case having traveled to an area reporting local transmission), primary (unknown source of infection), secondary (infection by a primary or imported case), tertiary (infection by a secondary case) and quaternary (infection by a tertiary case).

In order to map the epidemic, the GPS location of each case at the time of diagnosis was used.

The epidemic curve was constructed based on the number of cases (y-axis) and date of disease detection (x-axis) to account for confirmed asymptomatic cases and dates related to the identification of the disease epidemic and control measures.

The chain of transmission was built up from primary cases. The COVID-19 epidemic in Touba consisted of one (1) primary patient who was infected in a foreign country and several primary patients for whom the source of infection was not known. The primary case means the patient initially detected in the first epidemic cluster. Secondary cases estimated to be infected by primary cases were linked to the latter by lines or chains, tertiary cases estimated to be infected by secondary cases were linked to the latter by lines or chains, and quaternary cases estimated to be infected by tertiary cases were connected to them by lines.

**Etiological analyses**

In etiological analysis, we first measured the crude ORs of association with a Pearson Chi 2 test between the associated factors and COVID-19 as well as their 95% confidence interval and their p-value in a univariate logistic regression.

In multivariate analysis, the identification of the associated factors was performed by a stepwise top-down logistic regression. All independent variables with a $p<0.2$ in the univariate analysis as well as variables known to be confounding factors such as age and sex were included in the analysis to look for factors independently associated with COVID -19. Associations were tested by Mantel-Haenszel Chi 2. The measure of association was the adjusted odds ratio (ORa) with its 95% confidence interval. For interpretation of associations, the threshold $\alpha = 0.05$ was used.

## Results

**Epidemiological characteristics**

A total of 554 subjects were identified and analyzed. The

number COVID-19 positive cases was 232 (41.88%). The median age of positive cases was 29 years with extremes of 14 days and 100 years. The 20-40 years age group (46.75%) was more represented in both positive cases (44.40%) and negative cases (48.45%) (Table 1). Of all cases, 301 (54.33%) were men; among the positive cases, men were also more represented 130 (56.03%), i.e. a sex ratio (M / F) of 1.3. Five hundred and four (90.97%) of the patients lived in an urban setting and 221 (95.26%) were positive. Regarding exposure, 301 (54.33%) had contact with a confirmed case, of which 162 (69.83%) were positive; a total of 59 (10.65%) had visited the Ocass market among which 43 (18, 53%) positive for COVID-19; the cases having participated in a ceremony with gathering were 24 (4.33%) of which 15 (6.47%) positive out of the 232 confirmed cases; those who attended a public place were 55 (9.93%) of which 43 (18.53%) positive (Table 1).

**Table 1:** Sociodemographic characteristics of COVID-19 cases in Touba, March-May 2020.

| Sociodemographic characteristics | | Total N = 554 | COVID-19 + N = 232 | *p* |
|---|---|---|---|---|
| | | n (%) | n (%) | |
| **Age class** | [0-20 years] | 132 (*23.83*) | 54 (23.28) | |
| | [20-40 years] | 259 (*46.75*) | 103 (*44.40*) | *0.53* |
| | [40-60 years] | 109 (*19.68*) | 48 (*20.69*) | |
| | [60 years and over] | 54 (9.75) | 27 (11.64) | |
| **Sex** | Feminine | 253 (45.67) | 102 (43.97) | |
| | Male | 301 (54.33) | 130 (56.03) | *0.49* |
| **Place of residence** | Rural | 50 (9.03) | 11 (4.74) | |
| | Urban | 504 (90.97) | 221 (95.26) | *0.002* |
| **Contact** | No | 253 (45.67) | 70 (30.17) | |
| | Yes | 301 (54.33) | 162 (69.83) | *<0.01* |
| **Ocass market** | No | 495 (89.35) | 189 (81.47) | |
| | Yes | 59 (10.65) | 43 (18.53) | *<0.01* |
| **Ceremony** | No | 530 (95.67) | 217 (93.53) | |
| | Yes | 24 (4.33) | 15 (6.47) | *0.04* |
| **ERP *** | No | 499 (*90.07*) | 189 (81.47) | |
| | Yes | 55 (9.93) | 43 (18.53) | *<0.01* |

*Establishment open to the public

**Spatio-temporal characteristics of COVID-19 cases, Touba, March-May 2020**

**Source of contamination**

The source of contamination was found in 162 cases (69.82%) of which 141 (60.78%) were secondary, 18 (7.76%) tertiary, 2 (0.86%) quaternary contaminations. For 70 (30.1%), the source of infection was not known (primary) and 1 case (0.4%) was imported (Figure 1).

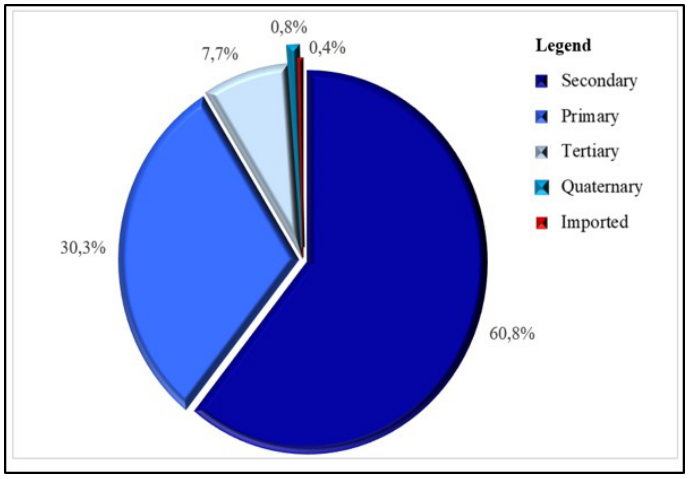


**Figure 1:** Distribution of the source of contamination of COVID-19 cases, Touba, March-May 2020.

**Geographical distribution of confirmed COVID-19 cases, Touba, March-May 2020**

The first COVID-19 case was recorded in the Darou Manane neighborhood. Twenty-three contacts of this first case have been confirmed, including 22 in the same household, 1 in the Khaïra district neighborhood and 1 in the Ndam neighborhood. Gradually, the cases spread to the outskirts and rural areas of Touba. In most neighborhoods, new cases were recorded. Obviously, the cases of COVID-19 were concentrated in the Touba 28 district in the main market of Touba (Ocass market) but also in the Darou Manane, Darou Khoudouss and Madiyana districts with a high population density (Figure 4).

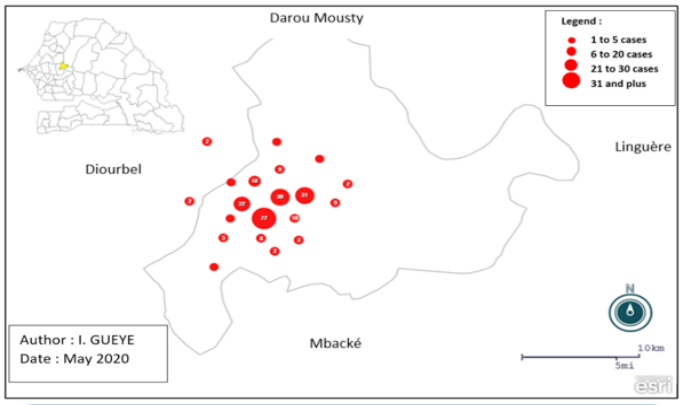


**Figure 2:** Geographical distribution of COVID-19 cases, Touba, March-May 2020.

***Evolution over time of confirmed COVID-19 cases, Touba, March-May 2020***

COVID-19 appeared on March 10 in Touba with a case imported from Italy. This case was the source of contamination of 24 household contacts, 9 of which were secondary and 15 were tertiary, thus forming a family cluster. This first wave was more or less contained thanks to quarantining the identified contacts. During this wave, the first community case appeared on March 17, 2020 but was not the source of any known secondary contamination. From March 18 to April 9, 2020, apart from the confirmation of a contact (tertiary case), no new contamination was noted. On April 10, a second community case was recorded without any known secondary contamination as well. It was from April 15 that COVID-19 spread rapidly in the city of Touba. A rapid expansion and sudden increase in the number of cases was noted. The epidemic curve reflects what may be a mixed outbreak pattern, with cases suggesting a common ongoing source and subsequent cases suggesting a propagated source (Figure 3).

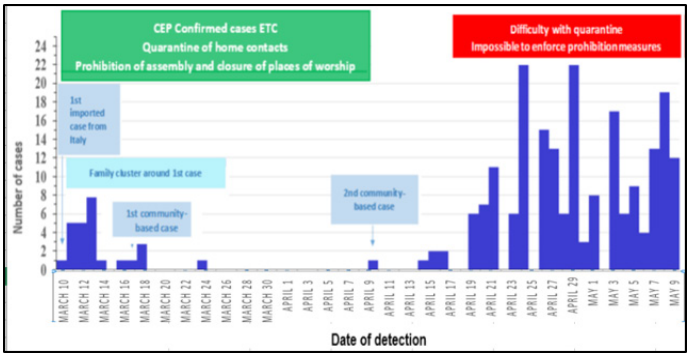


**Figure 3:** Daily evolution of confirmed cases of COVID-19, Touba, March-May 2020.

**Transmission chain of confirmed cases of COVID-19, Touba, March-May 2020**

A total of 71 patients were primary cases. Thirty-four chains of transmission were noted (47.88%) while 141, 18 and 2 were respectively secondary, tertiary and quaternary cases (Figure 4). The first primary case generated 19 secondary cases, 3 tertiary cases and 2 quaternary cases.

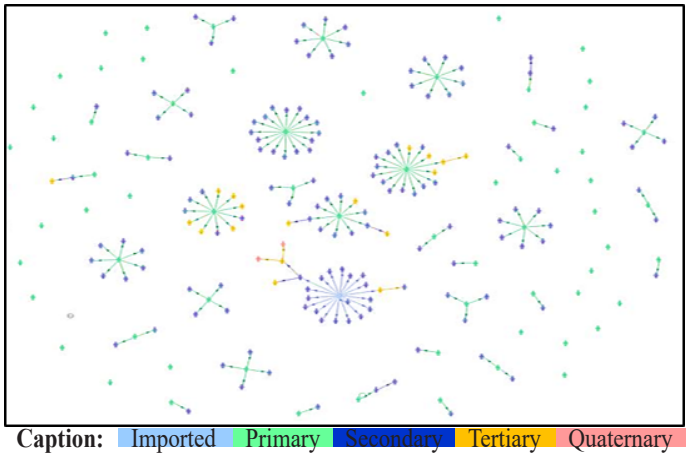


**Figure 4:** Transmission chain of confirmed cases of COVID-19, Touba, March-May 2020.

**Clinical characteristics of COVID-19 cases, Touba, March-May 2020**

Of the 232 confirmed cases, 106 (45.69%) were symptomatic. Symptoms in confirmed cases were fever (83.96%), cough (54.49%), headache (48.11%), pain (28.30%), rhinorrhea (20.75%), and sore throat (10.37%). Co-morbidities were present in 9.48% of cases. Of the 232 positive cases of COVID-19, 5 had died, resulting in a case fatality rate of 2.15% (Table 2).

**Table 2:** Clinical characteristics of confirmed COVID-19 cases, Touba, March-May 2020.

| Clinical features | Cases | Proportion (%) |
|---|---|---|
| **Clinical status (n = 232)** | | |
| Symptomatic | 106 | 45.69 |
| Asymptomatic | 126 | 54.11 |
| **Symptoms (n = 106)** | | |
| Fever | 89 | 83.96 |
| Sore throat | 11 | 10.37 |
| Cough | 62 | 54.49 |
| Rhinorrhea | 22 | 20.75 |
| Dyspnea | 5 | 4.71 |
| Headache | 51 | 48.11 |
| Algies | 30 | 28.30 |
| Other symptoms | 13 | 12.26 |
| **Comorbidities (n = 232)** | | |
| Yes | 22 | 9.48 |
| No | 210 | 90.52 |
| **Case outcome (n = 232)** | | |
| Living | 227 | 97.84 |
| Deceased | 5 | 2.16 |

**Factors associated with COVID-19 in Touba, March 10-May 10, 2020**

**Factors associated with COVID-19, Touba, March-May 2020, in univariate analysis**

In univariate analysis (Table 3), the variables associated with COVID-19 in our study were: urban residence (OR=2.77, 95% CI [1.39-5.53], p=0.005), contact (OR=3.04, 95% CI [2.13-4.35], p<0.001), attendance at the Ocass market (OR=4.34, 95%CI [2.38-7.94], p<0.001), attendance at a ceremony (OR=2.40, 95% CI [1.03-5.59], p<0.001), attendance at an establishment open to the public in the previous 14 days (OR=5.87, 95%CI [3.02-11.4], p<0.001).

**Table 3:** Factors associated with COVID-19, Touba, March-May 2020 in univariate analysis.

| Characteristics | Total | COVID-19 + | Crude OR | [95%CI] | *p* |
|---|---|---|---|---|---|
| | N = 554 | N = 232 | | | |
| | n (%) | n (%) | | | |
| **Age class** | | | | | *0.53* |
| [0-20 years) | 132 (*23.83*) | 54 (23.28) | Ref. | | |
| [20-40 years) | 259 (*46.75*) | 103 (*44.40*) | 0.95 | [0.62-1.46] | |
| [40-60 years) | 109 (*19.68*) | 48 (*20.69*) | 1.14 | [0.68-1.89] | |
| [60 years and over) | 54 (9.75) | 27 (11.64) | 1.44 | [0.76-2.72] | |
| **Sex** | | | | | |
| Feminine | 253 (45.67) | 102 (43.97) | Ref. | | |
| Male | 301 (54.33) | 130 (56.03) | 1.12 | [0.80-1.58] | *0.60* |
| **Place of residence** | | | | | |
| Rural | 50 (9.03) | 11 (4.74) | Ref. | | |
| **Urban** | **504 (90.97)** | **221 (95.26)** | **2.77** | **[1.39-5.53]** | ***<0.005*** |
| **Contact** | | | | | |
| No | 253 (45.67) | 70 (30.17) | Ref. | | |
| **Yes** | **301 (54.33)** | **162 (69.83)** | **3.04** | **[2.13-4.35]** | ***<0.001*** |
| **Ocass market** | | | | | |
| No | 495 (89.35) | 189 (81.47) | Ref. | | |
| **Yes** | **59 (10.65)** | **43 (18.53)** | **4.34** | **[2.38-7.94]** | ***<0.001*** |
| **Ceremony** | | | | | |
| No | 530 (95.67) | 217 (93.53) | Ref. | | |
| **Yes** | **24 (4.33)** | **15 (6.47)** | **2.40** | **[1.03-5.59]** | ***0.001*** |
| **Public open establishment** | | | | | |
| | 499 (*90.07*) | 189 (81.47) | Ref. | | |
| **Yes** | **55 (9.93)** | **43 (18.53)** | **5.87** | **[3.02-11.4]** | ***<0.001*** |

**- Associated factors adjusted for COVID-19, Touba, March-May 2020, in multivariate analysis**

In multivariate analysis (Table 4), urban area of residence (ORa =2.77 95%CI [1.39-5.53], p=0.005), contact (ORa=3.05, 95% CI [2.13-4.35], p<0.001), attendance at the Ocass market (ORa=4.35, 95%CI [2.38-7.94], p<0.001), participation in a ceremony (ORa=2.40, 95%CI [1.03-5.59], p<0.001), attendance at an establishment open to the public in the previous 14 days (ORa =5.88, 95%CI [3.02-11.43], p <0.001) were factors independently associated with COVID-19 in the health district of Touba from March to May 2020.

**Table 4:** Factors associated with COVID-19, Touba, March-May 2020, in multivariate analysis.

| Characteristics | COVID-19 + N = 232 | ORa [95% CI] | *p* |
|---|---|---|---|
| | n (%) | | |
| **Age class** | | | *0.15* |
| [0-20 years) | 54 (41) | Ref. | |
| [20-40 years) | 103 (*40*) | 0.95 [0.62-1.46] | |
| [40-60 years) | 48 (*44*) | 1.14 [0.68-1.90] | |
| [60 years and over] | 27 (27) | 1.44 [0.76-2.73] | |
| **Sex** | | | |
| Feminine | 102 (40) | Ref. | |
| Male | 130 (43) | 1.13 [0.80-1.58] | *0.93* |
| **Place of residence** | | | |
| Rural | 11 (22) | Ref. | |
| **Urban** | **221 (44)** | **2.77 [1.39-5.53]** | ***0.005*** |
| **Contact** | | | |
| No | 70 (28) | Ref. | |
| **Yes** | **162 (54)** | **3.05 [2.13-4.35]** | ***<0.001*** |
| **Ocass market** | | | |
| No | 189 (38) | Ref. | |
| **Yes** | **43 (73)** | **4.35 [2.38-7.94]** | ***<0.001*** |
| **Ceremony** | | | |
| No | 217 (41) | Ref. | |
| **Yes** | **15 (62)** | **2.40 [1.03-5.59]** | ***0.001*** |
| **Public open establishment** | | | |
| No | 189 (38) | Ref. | |
| **Yes** | **43 (78)** | **5.88 [3.02-11.43]** | ***<0.001*** |

## Discussion

Our study allowed us to estimate the epidemiological (age, sex, etc.) and clinical (fever, cough, headache, etc.) characteristics of COVID-19 in the health district of Touba. Our study also identified as associated factors, attendance of the Ocass market in Touba, the place of residence, contact, participation in a ceremony and attendance of at an establishment open to the public.

### Epidemiological and clinical characteristics

Analysis of data on confirmed cases in Touba showed a median patient age of 29 years, which is below the median age of 59 years reported in China [11,12].

In our study, subjects aged between 20 and 40 years represented 44.40%; this was in contrast to a study that had about half of the cases over the age of 50 [13].

Male sex was represented at 53.06%, which was in agreement with other studies [8,13].

The epidemic curve shows an epidemic trend in March. The cases that occurred could be a mode of transmission of exposure on a small scale (family cluster).

The results of our study show that the main clinical features of COVID-19 in confirmed cases were fever, cough, and headache. The clinical presentation of mild to moderate patients in Europe mainly consists of headache (70.3%), loss of smell (70.2%), nasal obstruction (67.8%) and asthenia (63,3%). The clinical presentation in Europe appears to be different from that reported in Asia. According to recent studies, COVID-19 infection of hospitalized and non-hospitalized patients in Asia was mainly associated with fever, cough, dyspnea and fatigue [11,14,15]. Specifically, in the study by Huang et al, the most common symptoms were fever (98%) and cough (76%) [14].

### Associated factors

Attendance at the Ocass market was associated with COVID-19 in Touba. The Ocass market is the largest market in the religious city of Touba, drawing a huge crowd daily. Mass gatherings were found to have the potential to spread the disease. This result was in agreement with those of several studies which showed that market attendance could lead to contamination [12,16-19].

Urban residence was associated with COVID-19. Spread of COVID-19 is known to be associated with high population density due to increased social mixing [9,20]; this is consistent with our finding of higher odds ratio of COVID-19 in urban areas.

In addition, our study found that contact with a confirmed case of COVID-19 was associated with the disease. In line with the results of previous studies [16,21], we found that 162 (69.83%) patients were infected with primary cases and were diagnosed while being monitored as contacts of confirmed patients. Control measures such as quarantine, travel restrictions and airport screening for travelers have been widely implemented to contain the spread of infections. The effectiveness of these containment measures in controlling the epidemic, however, remains inconclusive. An important implication to this is that the effectiveness of these control measures might be further hampered by a significant portion of asymptomatic patients (54.11%) [22] and pre-symptomatic transmission, as evidenced by certain analyses [23].

Participation in a ceremony was significantly associated with COVID-19 in Touba. Events in the context of the 2009 H1N1 pandemic for global health, the COVID-19 pandemic, may be sufficient to highlight the role of mass gatherings, mass migration and other forms of dense gatherings of people in crowded spaces on the emergence, sustainability and transmission of new pathogens [24]. The importance of mass gatherings on disease transmission is directly related to the efficiency of transmission expressed in epidemiological terms as the basic reproduction number [25].

Attendance at establishments open to the public was also associated with COVID-19 in Touba. Indeed, there were difficulties in enforcing barrier measures such as wearing a mask, physical distancing, hand washing or the use of hydro alcoholic solution in establishments open to the public. This result was consistent with the results of previous studies [5,24].

Our study had limitations. Data collected was not large enough to allow certain analyses (occupation, ethnicity, socioeconomic status, etc.). The lack of studies examining the epidemiological factors associated with COVID-19 has limited comparison with the current literature.

Moreover, as with many other studies, the lack of sensitivity of RT-PCR and potential country-related differences in the indications for sampling may have led to selection bias. Therefore, some COVID-19 cases, especially asymptomatic or paucisymptomatic cases could have escaped the system, especially in patients with lower viral loads.

## Conclusions

Knowledge of the factors associated with the transmission of an emerging infectious disease is the key to effective outbreak control. Our study identified the factors associated with COVID-19 in Touba. Attendance at the Ocass market in Touba, urban residence, contact with a confirmed case of COVID-19, participation at a ceremony and attendance at an open public facility were all associated with an increased risk of COVID-19. As the COVID-19 pandemic continues to spread rapidly, it is critical to maintain the ban on gatherings and to enforce barrier measures. It is also necessary to put in place a good community approach at the national and operational level against the spread of COVID-19.

## Declarations

### Acknowledgements

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### Ethics approval and consent to participate

This work was conducted in support of the ongoing epidemic response. Data collection is part of the ongoing public health investigation of a new epidemic by the ministry of health. Individual informed consent has been taken. The study was approved by the Health Emergency Operations Center. The data were analyzed anonymously with respect for confidentiality

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