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Characterization of the SARS-CoV-2 outbreak in the State of Qatar, February 28-April 18, 2020

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Abstract

Objective

To define the epidemiologic curve of COVID-19 in Qatar, determine factors associated with severe or critical illness, and study the temporal relation between public health measures and case finding

Design

Epidemiologic investigation

Setting and Participants

All confirmed COVID-19 cases in the State of Qatar between February 28 and April 18, 2020

Main Outcome Measures

Number of total and daily new COVID-19 infections; demographic characteristics and comorbidity burden and severity of infection; factors associated with severe or critical illness

Results

Between February 28 and April 18, 2020 (11:00AM local time), 5,685 cases of COVID-19 were identified. Mean age (SD) was 35.8(12.0) years, 88.9% were male and 8.7% were Qatari nationals. Overall, 83.6% had no concomitant comorbidity, and 3.0% had 3 or more comorbidities. The overwhelming majority (90.9%) were asymptomatic or with minimal symptoms, with 2.0% having severe or critical illness. Presence of hypertension or diabetes were associated with a higher risk of severe or critical illness. Seven deaths were observed during the time interval studied. The epidemiologic curve indicated two distinct patterns of

infection, a larger cluster among expatriate craft and manual workers, and a smaller one among Qatari nationals returning from abroad during the epidemic.

Conclusion

COVID-19 infections in Qatar started in two distinct clusters, but then became more widespread in the population through community transmission. Infections were mostly asymptomatic or with minimal symptoms and associated with very low mortality. Severe/critical illness was associated with presence of hypertension or diabetes.

Article Summary

Strengths and limitations of this study:

- National study with unified contact tracing and testing
- All testing done at a single lab, and all tests performed in the State of Qatar during the study period were included, providing a robust national estimate of the number of infected persons among those tested
- Comorbidities were retrieved from the electronic medical records using ICD-10 AM codes
- Exact geographic location and contact tracing data were not included in the current report
- It is possible that some persons still under care on the study end date may have progressed to more severe disease after that date

What is already known on this topic

As of May 3, 2020, over 3.4 million persons have been infected with SARS-CoV-2 and over 244,000 deaths have been reported in persons with COVID-19 infection. Those at higher risk of complications include persons over age 60 years and those with chronic comorbid conditions. Mortality rate varies widely among different countries, and this can be associated both to the capacity of the health system to provide effective intensive care including ventilators as well as other factors, including demographic differences. Public health measures seem effective, but there is debate on the extent to which the measures need to be aggressive or the duration for which they should be implemented.

What this study adds

This study reports on the epidemic curve in a population with a unique demographic structure, comprising an overwhelming majority of expatriates and young male craft and manual workers. This is also the first study that reports on the epidemic curve of an Arab country in the Eastern Mediterranean Region (EMR). The study also overlays major public health measures on the epidemic curve, to provide an understanding of the context in which the epidemic is progressing. Patients with confirmed COVID-19 in Qatar were young with few comorbidities. Case fatality rate was very low (only 7 deaths among 5,685 infected persons). Severe and critical illness were associated with presence of hypertension or diabetes.

Introduction

A cluster of patients with pneumonia of unknown etiology linked to a seafood wholesale market was first reported from Wuhan, China in December 2019.[1-4] A novel coronavirus, SARS-CoV-2 was isolated as the causative organism and the resultant disease was named COVID-19.[1,5] Initially linked to the seafood market and presumed to be transmitted from animals to humans, the virus has since spread quickly across the globe through human-to-human transmission.[6-9] As of May 3, 2020, more than 3.4 million cases and over 244,000 deaths have been reported globally. Published epidemiologic studies across a number of populations show significant differences in rates and severity of infection and in case fatality rates.[10] At this stage of a novel virus pandemic, analyzing transmission patterns in populations with unique demographic characteristics can add to our understanding of the disease dynamics. While it is difficult to isolate the effects of public health measures, such as quarantine, lockdown, and physical distancing, it is nevertheless useful to track the course of the epidemic in relation to the timeline of their implementation. We describe the demographic characteristics, comorbidity profile, and disease severity of patients with confirmed COVID-19 infection in Qatar. We also report on significant public health measures implemented to slow the progression of the epidemic in Qatar.

Qatar is a part of the six-country Gulf Cooperation Council, which also includes Saudi Arabia, Kuwait, Oman, Bahrain and the United Arab Emirates. Qatar has a unique population demographic profile. Among the 2.8 million residents of Qatar, expatriate workforce constitutes about 88% of the population.[11] Due to the nature of the expatriate workforce, the majority of the population in Qatar (~75%) are male, and the population pyramid is heavily concentrated in the 20-50 year age groups, particularly among males.[11] There is evidence that COVID-19 disproportionally affects males and outcomes are poorer in the older age group.[3,12,13] Understanding the epidemiologic curve and risk factors for serious infection in Qatar will be

important in understanding the epidemiology in countries with unique demographic characteristics.

Methods

Even before the first case of COVID-19 was identified in the country, Qatar had instituted extensive plans to identify and manage persons with COVID-19 infection. The existing tracking, tracing and identification mechanism within the Ministry of Public Health, with proven effectiveness during the MERS-CoV outbreak, was expanded and put on alert.[14,15] Testing for suspected cases started on February 5, 2020, and the first case was recorded on February 28, 2020. We used the tracking and reporting data from the Ministry of Public Health to determine the number of new cases diagnosed per day and their demographic characteristics between February 28, 2020 (date of identification of first case in Qatar) and April 18, 2020 (11:00 AM local time). All COVID-19 testing in Qatar was performed at the central laboratory of Hamad Medical Corporation, which is the public healthcare delivery arm for the State of Qatar and provides over 85% of the inpatient bed capacity in the State. Nasopharyngeal and throat swabs were collected from suspected cases with symptoms of influenza-like illness suggesting COVID-19 and, if confirmed, from close contacts. Real time RT-PCR was used to detect SARS-CoV-2 infection. Nationality of each tested person was ascertained from the official State Identification Card, which is issued to each national and expatriate worker and their dependents residing in Qatar. Comorbidities were retrieved from the electronic medical records where they are coded using the International Classification of Diseases 10th edition, Australian Modification. Severity of illness at the time of presentation was determined by expert coders using criteria suggested by the World Health Organization, including admission to an acute care or an intensive care bed, need for mechanical ventilation, oxygen saturation and supplemental oxygen requirement.[16] **(Supplementary table 1)** Severity of illness was categorized into 1) asymptomatic or minimal symptoms, 2) mild symptoms or uncomplicated upper respiratory tract

infection without clinical or radiographic evidence of pneumonia, 3) mild symptoms with clinical or radiographic evidence of pneumonia, 4) severely ill, and 5) critically ill.[16]

We created a timeline of newly diagnosed cases to study the progression of the epidemic in Qatar. Key governmental decisions taken by the Supreme Committee for Crisis Management and the Council of Ministers in response to the epidemic were marked on the timeline to show their temporal relation to the cases. Multivariable logistic regression was used to determine factors associated with severe and critical illness. Covariates of interest included in the model were age, gender, nationality and presence of comorbidities. Comorbidities with a total count of less than 15 were excluded because of the small numbers.

Changes in population movement was assessed using Google mobility reports, a publicly available tool that tracks movement of people who use mobile applications like Google Maps.[17] They show changes in visits and length of stay at various locations compared to a baseline. Baseline was the median value, for the corresponding day of the week, during the 5-week period between January 3, 2020 and February 6, 2020.[17]

Ethical Approval

The Institutional Review Board at Hamad Medical Corporation approved this study with an expedited status due to the emergency pandemic status of the COVID-19 outbreak.

Patient and Public Involvement

This study was conducted in response to a national and global public health emergency. There was no patient or public involvement. However, key elements of the data are shared with the public on a daily basis.

Results

Between February 5, 2020 and April 18, 2020 (11:00 AM local time), 60,645 persons were tested for SARS-CoV-2, of which 5,685 were confirmed positive. Before the first case was diagnosed, testing for SARS-CoV-2 focused on those with influenza-like illness and severe acute respiratory infection. The first cases were identified among quarantined travelers returning to Qatar on February 28, 2020, followed by the identification of a large cluster of over 300 infections on March 6, 2020 among expatriate craft and manual workers. Following the discovery of the first community cluster, testing was expanded to include contacts of new cases, persons in hotspots, that is areas where infections were diagnosed, individuals with suspected infection or suggestive symptoms, and travelers coming or returning to Doha. The rapid expansion of testing created a backlog, which was resolved through an investment in testing infrastructure that significantly increased the testing capacity to approximately 4,000 tests per day.

The number of new cases diagnosed by date of diagnosis is presented in **figure 1.** The epidemiologic curve showed two distinct patterns of infection transmission. A larger and sustained community transmission was observed among expatriate workers, predominantly among craft and manual workers, which subsequently reached other population segments. A second smaller cluster among Qatari nationals returning from overseas during the study period was not sustained over time. Subsequent smaller case clusters among Qatari nationals were traced to the local community. The number of tests performed per day and the number testing positive is provided in **supplementary figure 1.** The positivity rate, that is number of tests positive over total number of tests, is shown in **figure 2**. The positivity rate increased steadily with time, with somewhat of an accelerated rate after April 5, 2020.

The mean age (SD) of the infected persons was 35.8 (12.0) years and 88.9% were male **(Table 1).** Other baseline characteristics are also shown in **table 1.** The nationalities with highest frequency of infection were Indian (27.4%), Bangladeshi (18.9%), Nepalese (18.4%), Qatari (8.7%), and Pakistani (6.2%). The most common comorbidities were hypertension (6.9%), diabetes mellitus (6.0%), cardiovascular disease (4.4%) and chronic lung disease (3.0%). Comorbidity data were missing for 235 persons (4.1%). Among all infected persons, 4,753 (83.6%) had no known comorbidity and 697 (12.3%) had at least one comorbidity. An overwhelming majority of infected persons (90.9%) were either asymptomatic or had minimal symptoms, 0.8% had mild illness without evidence of pneumonia, 2.3% had mild illness with pneumonia, and 2% were severe or critically ill. Severity of illness data were missing for 223 (3.9%) persons. **(Table 1)**

A larger proportion of persons with mild illness with or without pneumonia and those with severe or critical illness had at least one comorbidity. **(Table 2)** Compared to those with asymptomatic or minimally symptomatic illness, prevalence of most comorbidities was 3-4 times higher among those with mild disease with or without pneumonia or severe/critical illness. Number of comorbidities by severity of illness is shown in **table 3.** Among persons with no comorbidity, 96.1% were asymptomatic or had minimal symptoms, 2.5% had mild illness with or without pneumonia, and 1.4% were severely or critical ill. Among persons with 2 or more comorbidities, 82.1% were asymptomatic or had minimal symptoms, 10.9% had mild illness with or without pneumonia, and 7.1% were severely or critical ill. **(Table 3)**

Seven deaths were observed during the time interval studied, corresponding to a case-fatality rate of 1.2 per 1000 cases. All seven deaths were males aged 40-88 years. All except one (74 years old male) had comorbidities, including diabetes (5 subjects), cardiovascular disease (5 subjects) and hypertension (3 subjects). One patient, 58 years old had 5 comorbidities

(diabetes, hypertension, cardiovascular disease, chronic kidney and liver disease). In a multivariable logistic regression model, presence of hypertension (OR 3.49; 95% CI 1.83,6.68) or diabetes (OR 3.17; 95% CI 1.76,5.71) were associated with a higher risk of severe or critical disease. **(Table 4)** Cardiovascular disease, chronic lung disease, chronic kidney disease and solid organ malignancy were not associated with a higher risk. We repeated the logistic regression analysis after excluding those with missing data and the results were nearly identical. **(Supplementary table 2)** We also repeated the analysis using number of comorbidities as covariates. Presence of any single comorbidity (OR 5.43, 95% CI 3.41,8.63) or any 3 or more comorbidities (OR 6.16, 95% CI 3.35,11.32) were associated with a higher risk of severe or critical illness. **(Supplementary table 3)**

Google mobility reports data demonstrated a significant decrease in number of people visiting retail and recreation outlets, grocery and pharmacy stores, parks, transit stations and workplaces over time. **(Table 5)** A concurrent increase in people staying in residential areas was observed over this timeframe. A snapshot on April 17 shows a 69% reduction in visits to retail and recreation areas, a 44% reduction in visits to grocery and pharmacy stores, a 64% decrease in visits to parks, a 68% decrease in visits to transit stations and a 38% decrease in visits to workplaces. A 21% increase in people at residential areas was observed on this date.

Discussion

We provide a characterization of the SARS-CoV-2 outbreak in Qatar, which offers new insights into the behavior of the pandemic in a unique demographic setting.

The first case in Qatar was identified on February 28, 2020, among returning travelers, which is nearly 9 weeks after the first cluster was reported from Wuhan, China.[18] During this time, infection had spread to multiple countries over four continents. This was also a critical time

during which the State of Qatar formulated a national plan to respond to the anticipated cases. Testing for SARS-CoV-2 started in Qatar on February 5, 2020 and the first major cluster of cases was identified on March 8, 2020 where over 300 cases were linked to 4 expatriate workers through aggressive contact tracing. Such aggressive identification and contact tracing and testing were probably the reasons for a small number of daily new cases till March 31, 2020. At that time, a large number of returning travelers and nationals were identified to have infection. The number of daily diagnosed infections accelerated in April, in part due to a large increase in number of daily tests, but also reflecting expansion of the epidemic in the wider population. This trend occurred predominantly in expatriate workers often living in more crowded areas and accommodations with frequent social mixing despite a national campaign to discourage peoples' movement except in urgent situations. The epidemic, however, eventually reached a larger population.

An overwhelming majority (>90%) of confirmed COVID-19 cases were asymptomatic or with minimal symptoms not requiring urgent medical care or hospitalization. This is likely due to the younger age of the population (mean age 35.8 years) and overall absence of any comorbidities in the vast majority of the infected persons. This reinforces our current understanding of the disease being mild or asymptomatic in a majority of the persons, particularly among the younger and healthier persons, as well as the strong role of age in the epidemiology of this infection. Similar to other studies, presence of comorbidities was associated with severe or critical disease.[1] We found a very low mortality among confirmed COVID-19 patients in Qatar, which may at least partly be attributable both to the timely and effective response of the health system and the demographic characteristics of the infected persons. It is conceivable that right censoring with the time delay between onset of disease to death may play a part, though similarly very low mortality after the study period ended does not support this. The role that

factors such as free access to high quality medical care for everybody in Qatar, availability of a high number of critical care beds, or differences in viral subtypes, played, needs further study.

In response to the spread of COVID-19, the country took a series of public health measures, including limiting incoming passenger flights into Doha through Hamad International Airport and providing free state quarantine facilities for returning travelers. A host of other measures were implemented gradually that promoted physical distancing including, closing retail stores in malls and shopping centers, closing entertainment and dining facilities, postponing or canceling large sports events and conferences, suspending classes in schools and universities, and mandating working from home for 80% of workers in the public and private sectors. The healthcare system was also reorganized to prioritize COVID-19 response over routine services. All positive cases including those without symptoms were admitted to isolation facilities by the public healthcare system. These public health measures were heavily promoted and widely communicated through social and traditional media outlets to all segments of society. Mobility data shows a significant reduction in visits to common retail, recreation, transit and workplace areas, which may have contributed to a reduction in spread of infection. There was a more pronounced reduction in mobility in the weeks following April 5th, which coincides with the significant rise in the reported number of positive cases.

Strengths of our study include unified contact tracing and testing, with all testing done at a single lab. All tests performed in the State of Qatar were included, providing a robust national estimate of the number of infected persons among those tested. There are limitations to our study. Comorbidities were retrieved from the electronic medical records using ICD-10 AM codes. Exact geographic location and contact tracing data were not included in the current report. Our study end date was April 18, 2020, and all persons with confirmed infection till that

date were included. However, it is possible that some persons may have progressed to more severe disease after this date.

In conclusion, we describe the evolution of COVID-19 epidemic in the State of Qatar. The epidemic predominantly affected males and younger population and was associated with no or minimal symptoms in a vast majority of the infected persons. Public health measures were instituted early and may have led to the slower growth compared with other countries which delayed such measures.

Funding

None

Competing interests:

None of the authors have any financial conflict of interest related to this article.

H.E. Dr. Hanan. M. Al Kuwari is the Minister of Public Health for the State of Qatar.

Ethical Approval

This study was approved by the Institutional Review Board at Hamad Medical Corporation. (MRC-05-011)

Patient Consent

A waiver of informed consent was granted.

Data Sharing Statement

No additional data are available

Patient of Public Involvement

There was not patient or public involvement in the design, conduct or reporting of this study.

Transparency declaration

The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Dissemination declaration

Dissemination to study participants or patient organizations is not possible/applicable.

Table 1. Characteristics of 5,685 patients with confirmed COVID-19 infection in Qatar between February 29 and April 18, 2020.

Variable	**N (%)**
Demographics	
Mean age, years (SD)	35.8 (12.0)
0-20 years	302 (5.3%)
21-40 years	3,666 (64.5%)
41-60 years	1,537 (27.0%)
>60 years	180 (3.2%)
Male sex	5,052 (88.9%)
Nationality	
Indian	1,559 (27.4%)
Bangladeshi	1,077 (18.9%)
Nepalese	1,047 (18.4%)
Qatari	497 (8.7%)
Pakistani	353 (6.2%)
Filipino	185 (3.3%)
Egyptian	179 (3.1%)
Sri Lankan	109 (1.9%)
Sudanese	91 (1.6%)
Others	588 (10.3%)
Comorbidities	
Hypertension	391 (6.9%)
Diabetes mellitus	344 (6.0%)
Cardiovascular disease	250 (4.4%)

Chronic lung disease	169 (3.0%)
Chronic kidney disease	35 (0.6%)
Solid organ malignancy	30 (0.5%)
Tuberculosis	13 (0.2%)
Chronic liver disease	12 (0.2%)
Autoimmune disease	6 (0.1%)
Missing	235 (4.1%)
Number of comorbidities (235 missing)	
0	4,753 (83.6%)
1	384 (6.8%)
2	139 (2.5%)
3	121 (2.1%)
≥4	53 (0.9%)
Missing	235 (4.1%)
Severity of illness	
Asymptomatic or minimal symptoms	5,168 (90.9%)
Mild illness without pneumonia	44 (0.8%)
Mild illness with pneumonia	133 (2.3%)
Severe illness	82 (1.4%)
Critical illness	35 (0.6%)
Missing	223 (3.9%)

Table 2. Prevalence of comorbidities by severity of illness.

	Asymptomatic or minimally symptomatic **N (%)**	**Mild illness with or without pneumonia** **N (%)**	**Severe/critical illness** **N (%)**
Hypertension	317 (6.1%)	41 (23.2%)	31 (26.5%)
Diabetes mellitus	281 (5.4%)	33 (18.6%)	30 (25.6%)
Cardiovascular disease	199 (3.8%)	31 (17.5%)	19 (16.2%)
Chronic lung disease	145 (2.8%)	12 (6.8%)	10 (8.6%)
Chronic kidney disease	25 (0.5%)	6 (3.4%)	4 (3.4%)
Solid organ malignancy	26 (0.5%)	2 (1.1%)	2 (1.7%)
Tuberculosis	10 (0.2%)	2 (1.1%)	1 (0.8%)
Chronic liver disease	10 (0.2%)	2 (1.1%)	0 (0%)
Autoimmune disease	5 (0.1%)	1 (0.6%)	0 (0%)

Table 3. Number of comorbidities by severity of illness.

Number of comorbidities	Asymptomatic or minimal symptoms, N (%)	Mild illness with or without pneumonia, N (%)	Severe/critical illness, N (%)
No comorbidity	4,582 (96.1%)	120 (2.5%)	67 (1.4%)
Only 1 comorbidity	330 (86.6%)	23 (6.0%)	28 (7.3%)
2 or more comorbidities	256 (82.1%)	34 (10.9%)	22 (7.1%)

Table 4. Factors associated with severe or critical illness (multivariable logistic regression model).

Variables	Odds Ratio	[95% Conf. Interval]		P-value
Age				
0-20 years (reference)	reference			
21-40 years	1.51	0.46	4.93	0.62
41-60 years	1.57	0.45	5.46	0.55
60+ years	1.39	0.3	6.49	0.94
Male gender	0.98	0.53	1.83	0.95
Qatari nationality (vs. non-Qatari)	0.83	0.43	1.6	0.58
Hypertension	3.49	1.83	6.68	0.0002
Diabetes mellitus	3.17	1.76	5.71	0.0001
Cardiovascular disease	0.54	0.24	1.22	0.14
Chronic lung disease	1.64	0.79	3.42	0.19
Chronic kidney disease	1.31	0.41	4.21	0.65
Cancer	1.26	0.28	5.66	0.77

Table 5. Relative change in people visiting areas of common interest in the State of Qatar.

(Comparison period January 3, 2020 – February 6, 2020)

	Qatar March 29	Qatar April 5	Qatar April 11	Qatar April 17
Retail & Recreation	-51%	-50%	-63%	-69%
Grocery & Pharmacy	-25%	-21%	-35%	-44%
Parks	-34%	-35%	-48%	-64%
Transit stations	-52%	-52%	-60%	-68%
Workplaces	-31%	-36%	-39%	-38%
Residential	+22%	+24%	+23%	+21%

Figure 1. Epidemiologic curve of patients with COVID-19 in Qatar.

Figure 2. Positivity rate among those tested for SARS-CoV-2 active infection by swab day.

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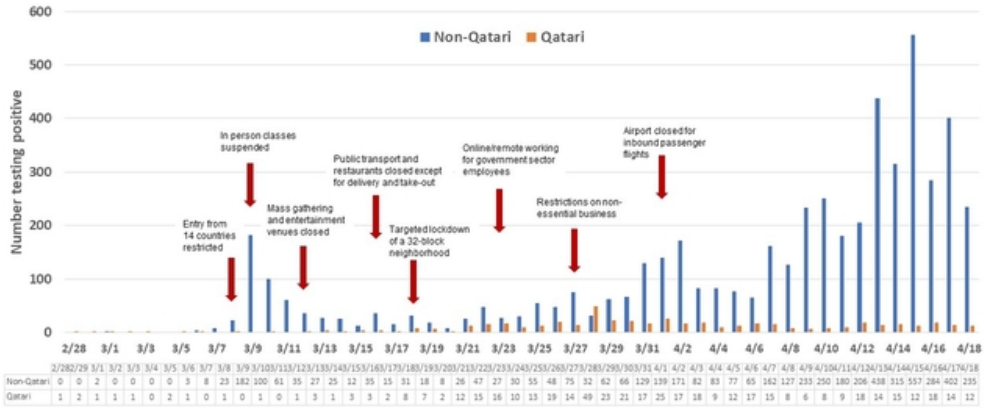


	2/28	2/29	3/1	3/2	3/3	3/4	3/5	3/6	3/7	3/8	3/9	3/10	3/11	3/12	3/13	3/14	3/15	3/16	3/17	3/18	3/19	3/20	3/21	3/22	3/23	3/24	3/25	3/26	3/27	3/28	3/29	3/30	3/31	4/1	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	4/18
Non-Qatari	0	0	2	0	0	0	0	3	8	23	182	100	61	35	27	25	12	55	15	31	18	8	26	47	27	30	55	48	75	32	62	66	129	139	171	82	83	77	65	162	127	233	250	180	206	438	315	557	284	402	235
Qatari	1	2	1	1	1	0	2	1	0	1	0	1	0	1	3	1	3	3	2	8	7	2	12	15	16	10	13	19	14	49	23	21	17	25	17	18	9	12	17	15	8	6	8	9	18	14	15	12	18	14	12

Figure 1

54x30mm (300 x 300 DPI)

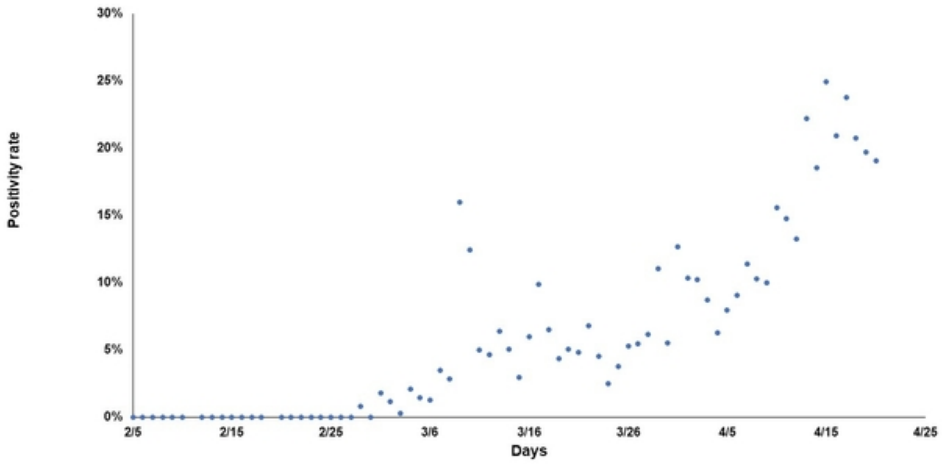
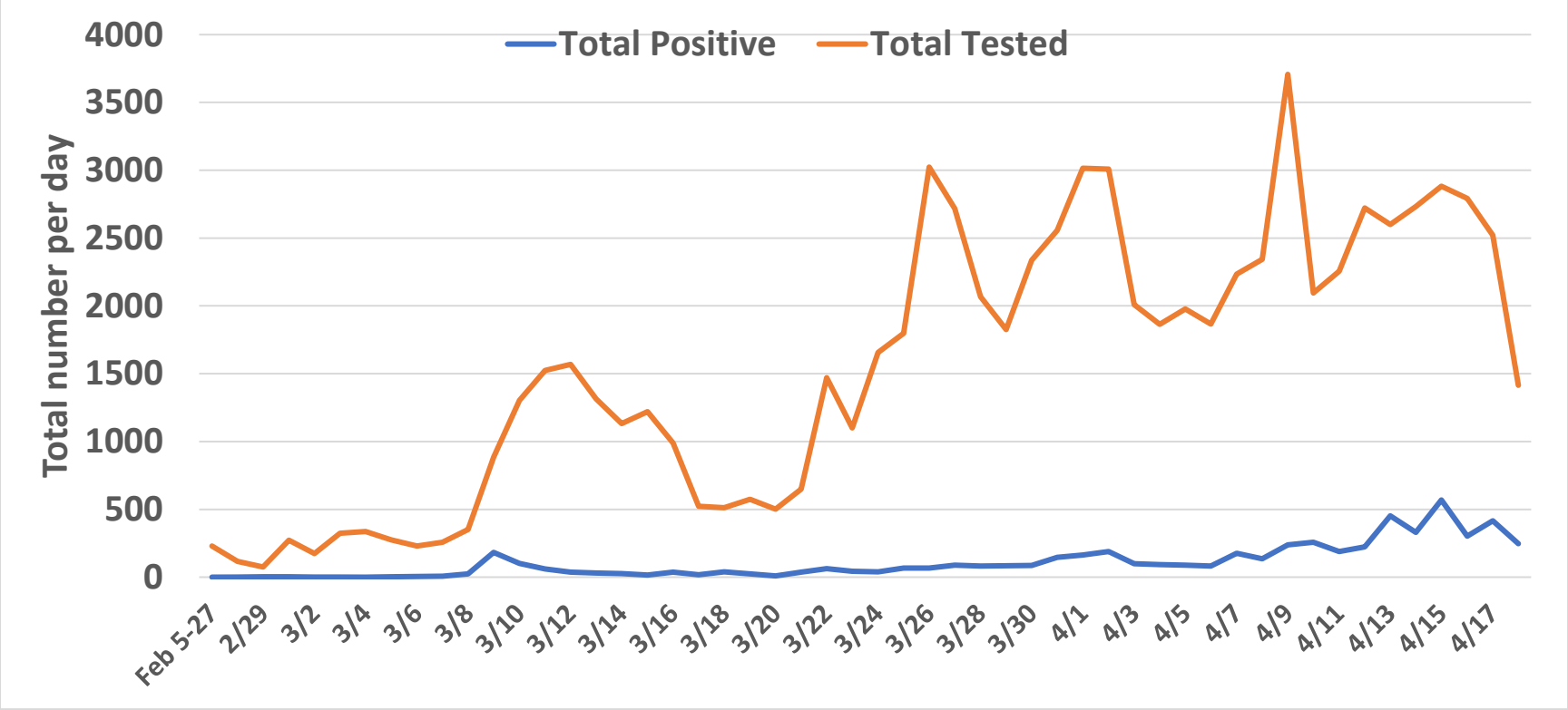


Figure 2

54x30mm (300 x 300 DPI)

Supplementary figure. Number of tests done and number of persons who tested positive per day.



Supplementary table. World Health Organization definitions of severity of illness in persons with COVID-19 infection.

Category		**Definition**
Mild		Patients with uncomplicated upper respiratory tract viral infection, may have non-specific symptoms such as fever, fatigue, cough (with or without sputum production), anorexia, malaise, muscle pain, sore throat, dyspnea, nasal congestion, or headache. Rarely, patients may also present with diarrhoea, nausea and vomiting. The elderly and immunosuppressed may present with atypical symptoms. Symptoms due to physiologic adaptations of pregnancy or adverse pregnancy events, such as e.g. dyspnea, fever, GI-symptoms or fatigue, may overlap with COVID-19 symptoms.
	Pneumonia	Adult with pneumonia but no signs of severe pneumonia and no need for supplemental oxygen. Child with non-severe pneumonia who has cough or difficulty breathing + fast breathing: fast breathing (in breaths/min): < 2 months: ≥ 60; 2–11 months: ≥ 50; 1–5 years: ≥ 40, and no signs of severe pneumonia.
Severe	Severe pneumonia	Adolescent or adult: fever or suspected respiratory infection, plus one of: respiratory rate > 30 breaths/min; severe respiratory distress; or SpO2 ≤ 93% on room air. Child with cough or difficulty in breathing, plus at least one of the following: central cyanosis or SpO2 < 90%; severe respiratory distress (e.g. grunting, very severe chest indrawing); signs of pneumonia with a general danger sign: inability to breastfeed or drink, lethargy or unconsciousness, or convulsions. Other signs of pneumonia may be present: chest indrawing, fast breathing (in breaths/min): < 2 months: ≥ 60; 2–11 months: ≥ 50; 1–5 years: ≥ 40. While the diagnosis is made on clinical grounds; chest imaging may identify or exclude some pulmonary complications.
Critical	Acute respiratory distress syndrome	Onset: within 1 week of a known clinical insult or new or worsening respiratory symptoms. Chest imaging (radiograph, CT scan, or lung ultrasound): bilateral opacities, not fully explained by volume overload, lobar or lung collapse, or nodules. Origin of pulmonary infiltrates: respiratory failure not fully explained by cardiac failure or fluid overload. Need objective assessment (e.g. echocardiography) to exclude hydrostatic cause of infiltrates/oedema if no risk factor present. Oxygenation impairment in adults: Mild ARDS: 200 mmHg < PaO2/FiO2 ≤ 300 mmHg (with PEEP or CPAP ≥ 5 cmH2O, or non-ventilated) Moderate ARDS: 100 mmHg < PaO2/FiO2 ≤ 200 mmHg (with PEEP ≥ 5 cmH2O, or non-ventilated) Severe ARDS: PaO2/FiO2 ≤ 100 mmHg (with PEEP ≥ 5 cmH2O, or non-ventilated) When PaO2 is not available, SpO2/FiO2 ≤ 315 suggests ARDS (including in non-ventilated patients).

		Oxygenation impairment in children: note OI = Oxygenation Index and OSI = Oxygenation Index using SpO2. Use PaO2-based metric when available. If PaO2 not available, wean FiO2 to maintain SpO2 ≤ 97% to calculate OSI or SpO2/FiO2 ratio: Bilevel (NIV or CPAP) ≥ 5 cmH2O via full face mask: PaO2/FiO2 ≤ 300 mmHg or SpO2/FiO2 ≤ 264 Mild ARDS (invasively ventilated): 4 ≤ OI < 8 or 5 ≤ OSI < 7.5 Moderate ARDS (invasively ventilated): 8 ≤ OI < 16 or 7.5 ≤ OSI < 12.3 Severe ARDS (invasively ventilated): OI ≥ 16 or OSI ≥ 12.3.
	Sepsis	Adults: life-threatening organ dysfunction caused by a dysregulated host response to suspected or proven infection.[1] Signs of organ dysfunction include: altered mental status, difficult or fast breathing, low oxygen saturation, reduced urine output, fast heart rate, weak pulse, cold extremities or low blood pressure, skin mottling, or laboratory evidence of coagulopathy, thrombocytopenia, acidosis, high lactate or hyperbilirubinemia. Children: suspected or proven infection and ≥ 2 aged based systemic inflammatory response syndrome criteria, of which one must be abnormal temperature or white blood cell count.
	Septic shock	Adults: persisting hypotension despite volume resuscitation, requiring vasopressors to maintain MAP ≥ 65 mmHg and serum lactate level > 2 mmol/L. Children: any hypotension (SBP < 5th centile or > 2 SD below normal for age) or two or three of the following: altered mental state; tachycardia or bradycardia (HR < 90 bpm or > 160 bpm in infants and HR < 70 bpm or > 150 bpm in children); prolonged capillary refill (> 2 sec) or feeble pulse; tachypnea; mottled or cool skin or petechial or purpuric rash; increased lactate; oliguria; hyperthermia or hypothermia.

Supplementary table 2. Factors associated with severe or critical illness after excluding those with missing severity of illness data (multivariable logistic regression model).

Variables	Odds Ratio	[95% Conf. Interval]		P-value
Age				
0-20 years (reference)	reference			
21-40 years	1.51	0.46	4.93	0.62
41-60 years	1.57	0.45	5.43	0.55
60+ years	1.40	0.30	6.55	0.94
Male gender	0.98	0.53	1.83	0.95
Qatari nationality (vs. non-Qatari)	0.83	0.43	1.60	0.58
Hypertension	3.48	1.82	6.66	0.0002
Diabetes mellitus	3.14	1.74	5.65	0.0001
Cardiovascular disease	0.55	0.24	1.22	0.14
Chronic lung disease	1.65	0.79	3.43	0.19
Chronic kidney disease	1.31	0.41	4.21	0.65
Cancer	1.25	0.28	5.65	0.77

Supplementary table 3. Factors associated with severe or critical illness by number of comorbidities (multivariable logistic regression model).

Variables	Odds Ratio	[95% Conf. Interval]		P-value
Age				
0-20 years (reference)				
21-40 years	1.42	0.43	4.67	0.75
41-60 years	1.49	0.43	5.19	0.65
60+ years	1.44	0.31	6.66	0.84
Male gender	0.96	0.51	1.78	0.89
Qatari nationality (vs. non-Qatari)	0.83	0.43	1.58	0.57
Number of comorbidities				
0 (reference)				
Any 1	5.43	3.41	8.63	0.01
3 or more	6.16	3.35	11.32	0.01

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Included
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Included
Objectives	3	State specific objectives, including any prespecified hypotheses	Included
Methods			
Study design	4	Present key elements of study design early in the paper	Included
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Included
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Included
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Included
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Included
Bias	9	Describe any efforts to address potential sources of bias	Limitations described
Study size	10	Explain how the study size was arrived at	Included
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Included
		(*b*) Describe any methods used to examine subgroups	N/A

			and interactions	
			(*c*) Explain how missing data were addressed	N/A
			(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
			(*e*) Describe any sensitivity analyses	N/A
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed		Included
		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders		Included
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures		Included
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		N/A
		(*b*) Report category boundaries when continuous variables were categorized		
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		Included
Discussion				
Key results	18	Summarise key results with reference to study objectives		Included
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		Included
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence		Included
Generalisability	21	Discuss the generalisability (external validity) of the study results		Included

Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Included

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Epidemiologic Investigation of the First 5,685 Cases of SARS-CoV-2 Infection in Qatar, February 28-April 18, 2020

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Epidemiologic Investigation of the First 5,685 Cases of SARS-CoV-2 Infection in Qatar, February 28-April 18, 2020

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Abstract

Objective

To define the epidemiologic curve of COVID-19 in Qatar and determine factors associated with severe or critical illness

Design

Case series of first 5,685 COVID-19 cases in Qatar

Setting and Participants

All confirmed COVID-19 cases in the State of Qatar between February 28 and April 18, 2020

Main Outcome Measures

Number of total and daily new COVID-19 infections; demographic characteristics and comorbidity burden and severity of infection; factors associated with severe or critical illness

Results

Between February 28 and April 18, 2020, 5,685 cases of COVID-19 were identified. Median age was 34 (IQR 28,43) years, 88.9% were male and 8.7% were Qatari nationals. Overall, 83.6% had no concomitant comorbidity, and 3.0% had 3 or more comorbidities. The overwhelming majority (90.9%) were asymptomatic or with minimal symptoms, with 2.0% having severe or critical illness. Seven deaths were observed during the time interval studied. Presence of hypertension or diabetes was associated with a higher risk of severe or critical illness, but age was not. The epidemiologic curve indicated two distinct patterns of infection, a larger cluster among expatriate craft and manual workers, and a smaller one among Qatari nationals returning from abroad during the epidemic.

Conclusion

COVID-19 infections in Qatar started in two distinct clusters, but then became more widespread in the population through community transmission. Infections were mostly asymptomatic or with minimal symptoms and associated with very low mortality. Severe/critical illness was associated with presence of hypertension or diabetes, but not with increasing age.

Article Summary

Strengths and limitations of this study:

- National study with unified contact tracing and testing
- All testing done at a single lab, and all tests performed in the State of Qatar during the study period were included, providing a robust national estimate of the number of infected persons among those tested
- Comorbidities were retrieved from the electronic medical records using ICD-10 AM codes
- Exact geographic location and contact tracing data were not included in the current report
- It is possible that some persons still under care on the study end date may have progressed to more severe disease after that date

Introduction

A cluster of patients with pneumonia of unknown etiology linked to a seafood wholesale market was first reported from Wuhan, China in December 2019.[1-4] A novel coronavirus, SARS-CoV-2 was isolated as the causative organism and the resultant disease was named COVID-19.[1,5] Initially presumed to be transmitted from animals to humans, the virus has since spread quickly across the globe through human-to-human transmission.[6-9] As of August 20, 2020, more than 22 million cases and over 791,000 deaths have been reported globally. Published epidemiologic studies across a number of populations show significant differences in rates and severity of infection and in case fatality rates.[10] At this stage of a novel virus pandemic, analyzing transmission patterns in populations with unique demographic characteristics can add to our understanding of the disease dynamics. While it is difficult to isolate the effects of public health measures, such as quarantine, lockdown, and physical distancing, it is nevertheless useful to track the course of the epidemic in relation to the timeline of their implementation for an understanding of the context in which the epidemic unfolded.

Qatar is a part of the six-country Gulf Cooperation Council (GCC), which also includes Saudi Arabia, Kuwait, Oman, Bahrain and the United Arab Emirates. Qatar has a unique population demographic profile. Among the 2.8 million residents of Qatar, expatriate workforce constitutes about 88% of the population.[11] Due to the nature of the expatriate workforce, the majority of the population in Qatar (~75%) are male, and the population pyramid is heavily concentrated in the 20-50 year age groups, particularly among males.[11] There is evidence that COVID-19 disproportionally affects males and outcomes are poorer in the older age group.[3,12,13] Influx or efflux of the population can also affect epidemic dynamics. Such changes in population can be expected in populations with a high proportion of non-national or non-native groups such as GCC countries. There were no travel restrictions in the early part of the study, i.e. from February 28 to March 30, 2020. A general restriction on all incoming flights into Qatar was implemented

on March 31, which halted almost all influx of visitors or residents into the country. Exit travel was not generally restricted. However, two factors diminished outbound travel sharply: 1) global restrictions on travel leading to a sharp reduction in all flights; 2) restriction of essential workers, e.g. healthcare workers, from taking leave and travelling except in urgent or emergency situations. Our main objective was to define the epidemiologic features of COVID-19 in Qatar, and to determine factors associated with severe or critical illness. Understanding the epidemiology and risk factors for serious infection in Qatar will be important in understanding the epidemiology in countries with unique demographic characteristics.

Methods

Even before the first case of COVID-19 was identified in the country, Qatar had instituted extensive plans to identify and manage persons with COVID-19 infection. The existing tracking, tracing and identification mechanism within the Ministry of Public Health, with proven effectiveness during the MERS-CoV outbreak, was expanded and put on alert.[14,15] Testing for suspected cases started on February 5, 2020, and the first case was recorded on February 28, 2020. Using the Ministry of Public Health national database of COVID-19 patients, we retrospectively identified all confirmed cases of COVID-19 infection between February 28, 2020 and April 18, 2020. All COVID-19 testing in Qatar was performed at the central laboratory of Hamad Medical Corporation, which is the public healthcare delivery arm for the State of Qatar and provides over 85% of the inpatient bed capacity in the State. During the study period, there was targeted, purposeful testing of persons presenting with symptoms of influenza-like illness suggesting COVID-19. For every person who tested positive, active and aggressive contact tracing was carried out by trained staff at the Ministry of Public Health. Nasopharyngeal and throat swabs were collected from suspected cases with symptoms of influenza-like illness suggesting COVID-19 and, if confirmed, from close contacts. Close contacts were identified based on the criteria published by the United States Centers for Disease Control and

Prevention, which define a close contact as “any individual who was within 6 feet of an infected person for at least 15 minutes starting from 2 days before illness onset (or, for asymptomatic patients, 2 days prior to positive specimen collection) until the time the patient is isolated”.[16] Real time RT-PCR was used to detect SARS-CoV-2 infection using TaqPath COVID-19 Combo Kit (Thermo Fisher Scientific, Waltham, Massachusetts) or Cobas SARS-CoV-2 Test (Roche Diagnostics, Rotkreuz, Switzerland). These tests are highly sensitive and specific with no cross-reactivity against multiple other respiratory viruses.[17,18] Nationality of each tested person was ascertained from the official State Identification Card, which is issued to each national and expatriate worker and their dependents residing in Qatar. Demographic characteristics and comorbidities were retrieved from the electronic medical records where they are coded using the International Classification of Diseases 10th edition, Australian Modification. Severity of illness at the time of presentation was determined by expert coders using criteria suggested by the World Health Organization, including admission to an acute care or an intensive care bed, need for mechanical ventilation, oxygen saturation and supplemental oxygen requirement.[19] **(Supplementary table 1)** Severity of illness was categorized into 1) asymptomatic or minimal symptoms, 2) mild symptoms or uncomplicated upper respiratory tract infection without clinical or radiographic evidence of pneumonia, 3) mild symptoms with clinical or radiographic evidence of pneumonia, 4) severely ill, and 5) critically ill.[19]

We created a timeline of newly diagnosed cases to study the progression of the epidemic in Qatar. Key governmental decisions taken by the Supreme Committee for Crisis Management and the Council of Ministers in response to the epidemic were marked on the timeline to show their temporal relation to the cases. Multivariable logistic regression was used to determine factors associated with severe and critical illness. Covariates of interest included in the model were age, gender, nationality and presence of comorbidities. Comorbidities with a total count of less than 15 were excluded because of the small numbers.

Changes in population movement was assessed using Google mobility reports, a publicly available tool that tracks movement of people who use mobile applications like Google Maps.[20] They show changes in visits and length of stay at various locations compared to a baseline. Baseline was the median value, for the corresponding day of the week, during the 5-week period between January 3, 2020 and February 6, 2020.[20]

Ethical Approval

The Institutional Review Board at Hamad Medical Corporation approved this study with an expedited status due to the emergency pandemic status of the COVID-19 outbreak.

Patient and Public Involvement

This study was conducted in response to a national and global public health emergency. There was no patient or public involvement. However, key elements of the data are shared with the public on a daily basis.

Results

Between February 5, 2020 and April 18, 2020 (11:00 AM local time), 60,645 persons were tested for SARS-CoV-2, of whom 5,685 were confirmed positive. Before the first case was diagnosed, testing for SARS-CoV-2 focused on those with influenza-like illness and severe acute respiratory infection. The first cases were identified among quarantined travelers returning to Qatar on February 28, 2020, followed by the identification of a large cluster of over 300 infections on March 6, 2020 among expatriate craft and manual workers. Following the discovery of the first community cluster, testing was expanded to include contacts of new cases, persons in hotspots, that is areas where infections were diagnosed, individuals with suspected infection or suggestive symptoms, and travelers coming or returning to Doha. The rapid

expansion of testing created a backlog, which was resolved through an investment in testing infrastructure that significantly increased the testing capacity to approximately 4,000 tests per day.

The number of new cases diagnosed by date of diagnosis is presented in **figure 1.** The epidemiologic curve showed two distinct patterns of infection transmission. A larger and sustained community transmission was observed among expatriate workers, predominantly among craft and manual workers, which subsequently reached other population segments. A second smaller cluster among Qatari nationals returning from overseas during the study period was not sustained over time. Subsequent smaller case clusters among Qatari nationals were traced to the local community. The number of tests performed per day and the number testing positive is provided in **supplementary figure 1.** The positivity rate, that is number of tests positive over total number of tests, is shown in **figure 2**. The positivity rate increased steadily with time, with somewhat of an accelerated rate after April 5, 2020.

The median age (IQR) of the infected persons was 34 (28,43) years and 88.9% were male **(Table 1).** Other baseline characteristics are also shown in **table 1.** The nationalities with highest frequency of infection were Indian (27.4%), Bangladeshi (18.9%), Nepalese (18.4%), Qatari (8.7%), and Pakistani (6.2%). The most common comorbidities were hypertension (6.9%), diabetes mellitus (6.0%), cardiovascular disease (4.4%) and chronic lung disease (3.0%). Comorbidity data were missing for 235 persons (4.1%). Among all infected persons, 4,753 (83.6%) had no known comorbidity and 697 (12.3%) had at least one comorbidity. An overwhelming majority of infected persons (90.9%) were either asymptomatic or had minimal symptoms, 0.8% had mild illness without evidence of pneumonia, 2.3% had mild illness with pneumonia, and 2% were severe or critically ill. Severity of illness data were missing for 223 (3.9%) persons. **(Table 1)**

A larger proportion of persons with mild illness with or without pneumonia and those with severe or critical illness had at least one comorbidity. **(Table 2)** Compared to those with asymptomatic or minimally symptomatic illness, prevalence of most comorbidities was 3-4 times higher among those with mild disease with or without pneumonia or severe/critical illness. Severity of illness by number of comorbidities is shown in **table 3.** Among persons with no comorbidity, 96.1% were asymptomatic or had minimal symptoms, 2.5% had mild illness with or without pneumonia, and 1.4% were severely or critical ill. Among persons with 2 or more comorbidities, 82.1% were asymptomatic or had minimal symptoms, 10.9% had mild illness with or without pneumonia, and 7.1% were severely or critical ill. **(Table 3)**

Seven deaths were observed during the time interval studied, corresponding to a case-fatality rate of 1.2 per 1,000 cases. All seven deaths were males aged 40-88 years. All except one (74 years old male) had comorbidities, including diabetes (5 subjects), cardiovascular disease (5 subjects) and hypertension (3 subjects). One patient, 58 years old had 5 comorbidities (diabetes, hypertension, cardiovascular disease, chronic kidney and liver disease). In a multivariable logistic regression model, presence of hypertension (OR 3.49; 95% CI 1.83,6.68) or diabetes (OR 3.17; 95% CI 1.76,5.71) were associated with a higher risk of severe or critical disease. **(Table 4)** Cardiovascular disease, chronic lung disease, chronic kidney disease and solid organ malignancy were not associated with a higher risk. We repeated the logistic regression analysis after excluding those with missing data and the results were nearly identical. **(Supplementary table 2)** We also repeated the analysis using number of comorbidities as covariates. Presence of any single comorbidity (OR 5.43, 95% CI 3.41,8.63) or any 3 or more comorbidities (OR 6.16, 95% CI 3.35,11.32) were associated with a higher risk of severe or critical illness. **(Supplementary table 3)**

In a subsequent report in which the first 5,000 patients with COVID-19 infection in Qatar were followed for up to 60 days after diagnosis, a total of 1,424 patients (28.5%) required hospitalization, out of which 108 (7.6%) were admitted to ICU, 14 patients (0.28%) had died, 10 (0.2%) were still in hospital, and two (0.04%) were still in ICU.[21]

Google mobility reports data demonstrated a significant decrease in number of people visiting retail and recreation outlets, grocery and pharmacy stores, parks, transit stations and workplaces over time. **(Table 5)** A concurrent increase in people staying in residential areas was observed over this timeframe. A snapshot on April 17 shows a 69% reduction in visits to retail and recreation areas, a 44% reduction in visits to grocery and pharmacy stores, a 64% decrease in visits to parks, a 68% decrease in visits to transit stations and a 38% decrease in visits to workplaces. A 21% increase in people at residential areas was observed on this date.

Discussion

We provide a characterization of the SARS-CoV-2 outbreak in Qatar, which offers new insights into the behavior of the pandemic in a unique demographic setting.

The first case in Qatar was identified on February 28, 2020, among returning travelers, which is nearly 9 weeks after the first cluster was reported from Wuhan, China.[22] During this time, infection had spread to multiple countries over four continents. This was also a critical time during which the State of Qatar formulated a national plan to respond to the anticipated cases. Testing for SARS-CoV-2 started in Qatar on February 5, 2020 and the first major cluster of cases was identified on March 8, 2020 where over 300 cases were linked to 4 expatriate workers through aggressive contact tracing. Such aggressive identification and contact tracing and testing were probably the reasons for a small number of daily new cases till March 31,

2020. At that time, a large number of returning travelers and nationals were identified to have infection. The number of daily diagnosed infections accelerated in April, in part due to a large increase in number of daily tests, but also reflecting expansion of the epidemic in the wider population. This trend occurred predominantly in expatriate workers often living in more crowded areas and accommodations with frequent social mixing despite a national campaign to discourage peoples' movement except in urgent situations. The epidemic, however, eventually reached a larger population.

An overwhelming majority (>90%) of confirmed COVID-19 cases were asymptomatic or with minimal symptoms not requiring urgent medical care or hospitalization. This is likely due to the younger age of the population (mean age 35.8 years) and overall absence of any comorbidities in the vast majority of the infected persons. This reinforces our current understanding of the disease being mild or asymptomatic in a majority of the persons, particularly among the younger and healthier persons, as well as the strong role of age in the epidemiology of this infection. Similar to other studies, presence of comorbidities was associated with severe or critical disease.[1] We found a very low mortality among confirmed COVID-19 patients in Qatar, which may at least partly be attributable both to the timely and effective response of the health system and the demographic characteristics of the infected persons. It is conceivable that right censoring with the time delay between onset of disease to death may play a part, though similarly very low mortality after the study period ended does not support this. The role that factors such as free access to high quality medical care for everybody in Qatar, availability of a high number of critical care beds, or differences in viral subtypes, played, needs further study.

In response to the spread of COVID-19, the country took a series of public health measures, including limiting incoming passenger flights into Doha through Hamad International Airport and providing free state quarantine facilities for returning travelers. A host of other measures were

implemented gradually that promoted physical distancing including, closing retail stores in malls and shopping centers, closing entertainment and dining facilities, postponing or canceling large sports events and conferences, suspending classes in schools and universities, and mandating working from home for 80% of workers in the public and private sectors. The healthcare system was also reorganized to prioritize COVID-19 response over routine services. All positive cases including those without symptoms were admitted to isolation facilities by the public healthcare system. These public health measures were heavily promoted and widely communicated through social and traditional media outlets to all segments of society. Mobility data shows a significant reduction in visits to common retail, recreation, transit and workplace areas, which may have contributed to a reduction in spread of infection. There was a more pronounced reduction in mobility in the weeks following April 5th, which coincides with the significant rise in the reported number of positive cases.

The pandemic has affected nearly every country and territory in the world. However, infection rates and case fatality rates vary widely among countries. For example, crude case fatality rate is 3.2% in the US, 7.5% in Canada, 15% in the UK, but only 0.16% in Qatar and 0.67% in Kuwait (as of August 10, 2020).[23] It has been postulated that the population demographics and comorbidity burden are the key determinants of the variability in case fatality rates. However, these differences alone are unlikely to fully account for the widely variable case fatality rates. Testing per capita, seroprevalence among the general population, availability of acute and intensive care beds, living arrangements of infected persons and access to promising therapeutic options may provide additional explanations for the difference.

Strengths of our study include unified contact tracing and testing, with all testing done at a single lab. All tests performed in the State of Qatar were included, providing a robust national estimate of the number of infected persons among those tested. There are limitations to our

study. Comorbidities were retrieved from the electronic medical records using ICD-10 AM codes. Exact geographic location and contact tracing data were not included in the current report. Our study end date was April 18, 2020, and all persons with confirmed infection till that date were included. However, it is possible that some persons may have progressed to more severe disease after this date. Some of these data are the subject of another report with a brief summary provided in the preceding paragraph. Finally, the testing for COVID-19 during the study period was not population based which may affect the true infection rates and outcomes.

In conclusion, we describe the evolution of COVID-19 epidemic in the State of Qatar. For the population tested, the epidemic predominantly affected males and younger population and was associated with no or minimal symptoms in a vast majority of the infected persons. Hypertension and diabetes were associated, but increasing age was not associated with a higher risk of severe or critical illness. Public health measures were instituted early and may have led to the slower growth compared with other countries which delayed such measures.

Funding

None

Competing interests:

None of the authors have any financial conflict of interest related to this article.

H.E. Dr. Hanan. M. Al Kuwari is the Minister of Public Health for the State of Qatar.

Ethical Approval

This study was approved by the Institutional Review Board at Hamad Medical Corporation. (MRC-05-011)

Patient Consent

A waiver of informed consent was granted.

Data Sharing Statement

No additional data are available

Patient of Public Involvement

There was not patient or public involvement in the design, conduct or reporting of this study.

Transparency declaration

The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Dissemination declaration

Dissemination to study participants or patient organizations is not possible/applicable.

Table 1. Characteristics of 5,685 patients with confirmed COVID-19 infection in Qatar between February 29 and April 18, 2020.

Variable	**N (%)**
Demographics	
Mean age, years (SD)	35.8 (12.0)
Median age, years (IQR)	34 (28,43)
0-20 years	302 (5.3%)
21-40 years	3,666 (64.5%)
41-60 years	1,537 (27.0%)
>60 years	180 (3.2%)
Male sex	5,052 (88.9%)
Nationality	
Indian	1,559 (27.4%)
Bangladeshi	1,077 (18.9%)
Nepalese	1,047 (18.4%)
Qatari	497 (8.7%)
Pakistani	353 (6.2%)
Filipino	185 (3.3%)
Egyptian	179 (3.1%)
Sri Lankan	109 (1.9%)
Sudanese	91 (1.6%)
Others	588 (10.3%)
Comorbidities	
Hypertension	391 (6.9%)
Diabetes mellitus	344 (6.0%)

Cardiovascular disease	250 (4.4%)
Chronic lung disease	169 (3.0%)
Chronic kidney disease	35 (0.6%)
Solid organ malignancy	30 (0.5%)
Tuberculosis	13 (0.2%)
Chronic liver disease	12 (0.2%)
Autoimmune disease	6 (0.1%)
Missing	235 (4.1%)
Number of comorbidities (235 missing)	
0	4,753 (83.6%)
1	384 (6.8%)
2	139 (2.5%)
3	121 (2.1%)
≥4	53 (0.9%)
Missing	235 (4.1%)
Severity of illness	
Asymptomatic or minimal symptoms	5,168 (90.9%)
Mild illness without pneumonia	44 (0.8%)
Mild illness with pneumonia	133 (2.3%)
Severe illness	82 (1.4%)
Critical illness	35 (0.6%)
Missing	223 (3.9%)

Table 2. Prevalence of comorbidities by severity of illness.

	Asymptomatic or minimally symptomatic **N (%)**	**Mild illness with or without pneumonia** **N (%)**	**Severe/critical illness** **N (%)**
Hypertension	317 (6.1)	41 (23.2)	31 (26.5)
Diabetes mellitus	281 (5.4)	33 (18.6)	30 (25.6)
Cardiovascular disease	199 (3.8)	31 (17.5)	19 (16.2)
Chronic lung disease	145 (2.8)	12 (6.8)	10 (8.6)
Chronic kidney disease	25 (0.5)	6 (3.4)	4 (3.4)
Solid organ malignancy	26 (0.5)	2 (1.1)	2 (1.7)
Tuberculosis	10 (0.2)	2 (1.1)	1 (0.8)
Chronic liver disease	10 (0.2)	2 (1.1)	0 (0)
Autoimmune disease	5 (0.1)	1 (0.6)	0 (0)

Table 3.Severity of illness by number of comorbidities

Number of comorbidities	Asymptomatic or minimal symptoms, N (%)	Mild illness with or without pneumonia, N (%)	Severe/critical illness, N (%)
No comorbidity	4,582 (96.1%)	120 (2.5%)	67 (1.4%)
Only 1 comorbidity	330 (86.6%)	23 (6.0%)	28 (7.3%)
2 or more comorbidities	256 (82.1%)	34 (10.9%)	22 (7.1%)

Table 4. Factors associated with severe or critical illness (multivariable logistic regression model).

Variables	Odds Ratio	[95% Conf. Interval]		P-value
Age				
0-20 years (reference)	reference			
21-40 years	1.51	0.46	4.93	0.62
41-60 years	1.57	0.45	5.46	0.55
60+ years	1.39	0.3	6.49	0.94
Male gender	0.98	0.53	1.83	0.95
Qatari nationality (vs. non-Qatari)	0.83	0.43	1.6	0.58
Hypertension	3.49	1.83	6.68	0.0002
Diabetes mellitus	3.17	1.76	5.71	0.0001
Cardiovascular disease	0.54	0.24	1.22	0.14
Chronic lung disease	1.64	0.79	3.42	0.19
Chronic kidney disease	1.31	0.41	4.21	0.65
Cancer	1.26	0.28	5.66	0.77

Table 5. Relative change in people visiting areas of common interest in the State of Qatar.

(Comparison period January 3, 2020 – February 6, 2020)

	Qatar March 29	Qatar April 5	Qatar April 11	Qatar April 17
Retail & Recreation	-51%	-50%	-63%	-69%
Grocery & Pharmacy	-25%	-21%	-35%	-44%
Parks	-34%	-35%	-48%	-64%
Transit stations	-52%	-52%	-60%	-68%
Workplaces	-31%	-36%	-39%	-38%
Residential	+22%	+24%	+23%	+21%

Figure 1. Epidemiologic curve of patients with COVID-19 in Qatar.

Figure 2. Positivity rate among those tested for SARS-CoV-2 active infection by swab day.

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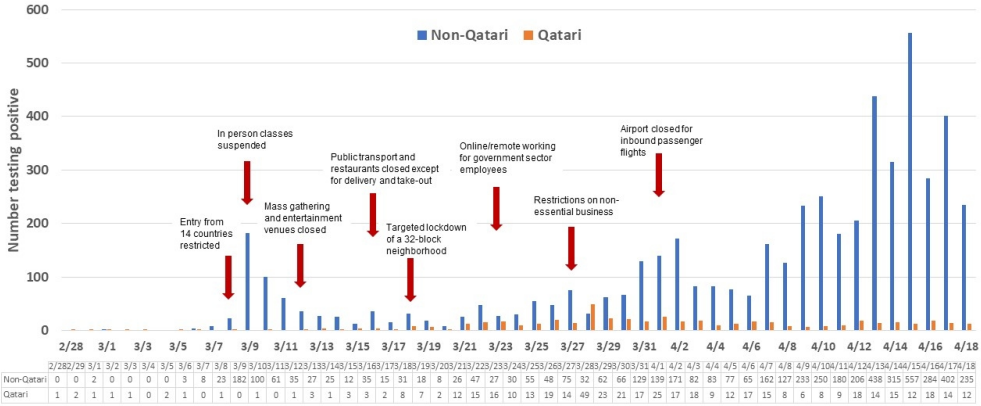


	2/28	2/29	3/1	3/2	3/3	3/4	3/5	3/6	3/7	3/8	3/9	3/10	3/11	3/12	3/13	3/14	3/15	3/16	3/17	3/18	3/19	3/20	3/21	3/22	3/23	3/24	3/25	3/26	3/27	3/28	3/29	3/30	3/31	4/1	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	4/18
Non-Qatari	0	0	2	0	0	0	0	3	8	23	182	100	61	35	27	25	12	35	15	31	18	8	26	47	27	30	55	48	75	32	62	66	129	139	171	82	83	77	65	162	127	233	250	180	206	438	315	557	284	402	235
Qatari	1	2	1	1	1	0	2	1	0	1	0	1	0	1	3	1	3	3	2	8	7	2	12	15	16	10	13	19	14	49	23	21	17	25	17	18	9	12	17	15	8	6	8	9	18	14	15	12	18	14	12

Figure 1

54x30mm (600 x 600 DPI)

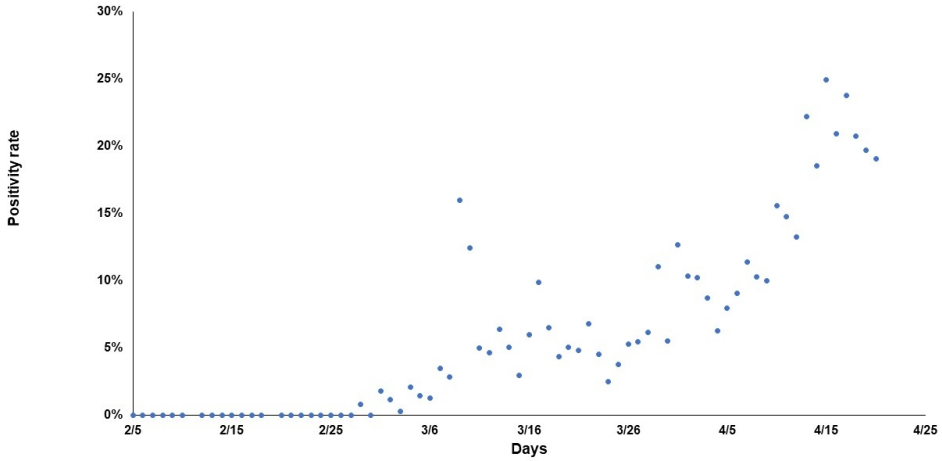
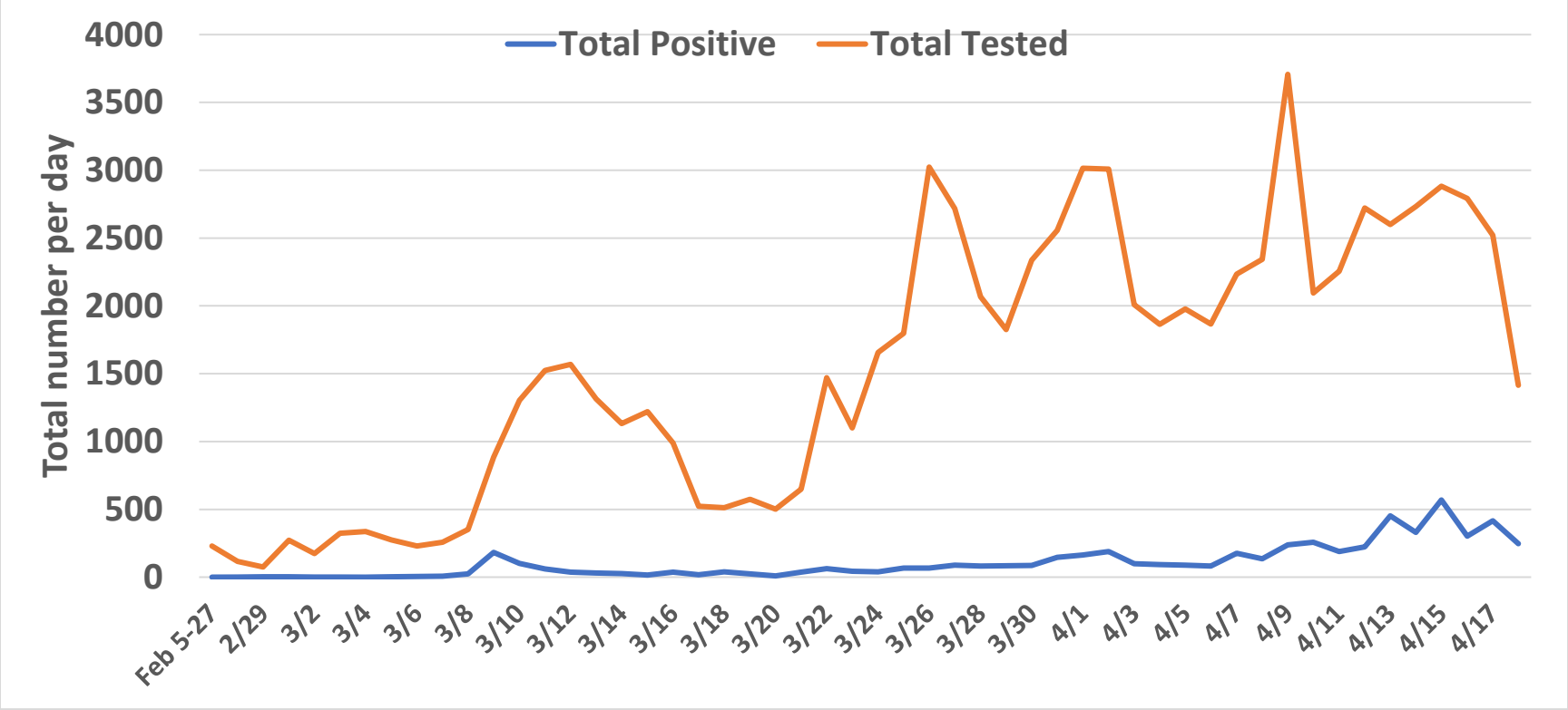


Figure 2

54x30mm (600 x 600 DPI)

Supplementary figure. Number of tests done and number of persons who tested positive per day.



Supplementary table. World Health Organization definitions of severity of illness in persons with COVID-19 infection.

Category		Definition
Mild		Patients with uncomplicated upper respiratory tract viral infection, may have non-specific symptoms such as fever, fatigue, cough (with or without sputum production), anorexia, malaise, muscle pain, sore throat, dyspnea, nasal congestion, or headache. Rarely, patients may also present with diarrhoea, nausea and vomiting. The elderly and immunosuppressed may present with atypical symptoms. Symptoms due to physiologic adaptations of pregnancy or adverse pregnancy events, such as e.g. dyspnea, fever, GI-symptoms or fatigue, may overlap with COVID-19 symptoms.
	Pneumonia	Adult with pneumonia but no signs of severe pneumonia and no need for supplemental oxygen. Child with non-severe pneumonia who has cough or difficulty breathing + fast breathing: fast breathing (in breaths/min): < 2 months: ≥ 60; 2–11 months: ≥ 50; 1–5 years: ≥ 40, and no signs of severe pneumonia.
Severe	Severe pneumonia	Adolescent or adult: fever or suspected respiratory infection, plus one of: respiratory rate > 30 breaths/min; severe respiratory distress; or SpO2 ≤ 93% on room air. Child with cough or difficulty in breathing, plus at least one of the following: central cyanosis or SpO2 < 90%; severe respiratory distress (e.g. grunting, very severe chest indrawing); signs of pneumonia with a general danger sign: inability to breastfeed or drink, lethargy or unconsciousness, or convulsions. Other signs of pneumonia may be present: chest indrawing, fast breathing (in breaths/min): < 2 months: ≥ 60; 2–11 months: ≥ 50; 1–5 years: ≥ 40. While the diagnosis is made on clinical grounds; chest imaging may identify or exclude some pulmonary complications.
Critical	Acute respiratory distress syndrome	Onset: within 1 week of a known clinical insult or new or worsening respiratory symptoms. Chest imaging (radiograph, CT scan, or lung ultrasound): bilateral opacities, not fully explained by volume overload, lobar or lung collapse, or nodules. Origin of pulmonary infiltrates: respiratory failure not fully explained by cardiac failure or fluid overload. Need objective assessment (e.g. echocardiography) to exclude hydrostatic cause of infiltrates/oedema if no risk factor present. Oxygenation impairment in adults: Mild ARDS: 200 mmHg < PaO2/FiO2 ≤ 300 mmHg (with PEEP or CPAP ≥ 5 cmH2O, or non-ventilated) Moderate ARDS: 100 mmHg < PaO2/FiO2 ≤ 200 mmHg (with PEEP ≥ 5 cmH2O, or non-ventilated) Severe ARDS: PaO2/FiO2 ≤ 100 mmHg (with PEEP ≥ 5 cmH2O, or non-ventilated) When PaO2 is not available, SpO2/FiO2 ≤ 315 suggests ARDS (including in non-ventilated patients).

		Oxygenation impairment in children: note OI = Oxygenation Index and OSI = Oxygenation Index using SpO2. Use PaO2-based metric when available. If PaO2 not available, wean FiO2 to maintain SpO2 ≤ 97% to calculate OSI or SpO2/FiO2 ratio: Bilevel (NIV or CPAP) ≥ 5 cmH2O via full face mask: PaO2/FiO2 ≤ 300 mmHg or SpO2/FiO2 ≤ 264 Mild ARDS (invasively ventilated): 4 ≤ OI < 8 or 5 ≤ OSI < 7.5 Moderate ARDS (invasively ventilated): 8 ≤ OI < 16 or 7.5 ≤ OSI < 12.3 Severe ARDS (invasively ventilated): OI ≥ 16 or OSI ≥ 12.3.
	Sepsis	Adults: life-threatening organ dysfunction caused by a dysregulated host response to suspected or proven infection.[1] Signs of organ dysfunction include: altered mental status, difficult or fast breathing, low oxygen saturation, reduced urine output, fast heart rate, weak pulse, cold extremities or low blood pressure, skin mottling, or laboratory evidence of coagulopathy, thrombocytopenia, acidosis, high lactate or hyperbilirubinemia. Children: suspected or proven infection and ≥ 2 aged based systemic inflammatory response syndrome criteria, of which one must be abnormal temperature or white blood cell count.
	Septic shock	Adults: persisting hypotension despite volume resuscitation, requiring vasopressors to maintain MAP ≥ 65 mmHg and serum lactate level > 2 mmol/L. Children: any hypotension (SBP < 5th centile or > 2 SD below normal for age) or two or three of the following: altered mental state; tachycardia or bradycardia (HR < 90 bpm or > 160 bpm in infants and HR < 70 bpm or > 150 bpm in children); prolonged capillary refill (> 2 sec) or feeble pulse; tachypnea; mottled or cool skin or petechial or purpuric rash; increased lactate; oliguria; hyperthermia or hypothermia.

Supplementary table 2. Factors associated with severe or critical illness after excluding those with missing severity of illness data (multivariable logistic regression model).

Variables	Odds Ratio	[95% Conf. Interval]		P-value
Age				
0-20 years (reference)	reference			
21-40 years	1.51	0.46	4.93	0.62
41-60 years	1.57	0.45	5.43	0.55
60+ years	1.40	0.30	6.55	0.94
Male gender	0.98	0.53	1.83	0.95
Qatari nationality (vs. non-Qatari)	0.83	0.43	1.60	0.58
Hypertension	3.48	1.82	6.66	0.0002
Diabetes mellitus	3.14	1.74	5.65	0.0001
Cardiovascular disease	0.55	0.24	1.22	0.14
Chronic lung disease	1.65	0.79	3.43	0.19
Chronic kidney disease	1.31	0.41	4.21	0.65
Cancer	1.25	0.28	5.65	0.77

Supplementary table 3. Factors associated with severe or critical illness by number of comorbidities (multivariable logistic regression model).

Variables	Odds Ratio	[95% Conf. Interval]		P-value
Age				
0-20 years (reference)				
21-40 years	1.42	0.43	4.67	0.75
41-60 years	1.49	0.43	5.19	0.65
60+ years	1.44	0.31	6.66	0.84
Male gender	0.96	0.51	1.78	0.89
Qatari nationality (vs. non-Qatari)	0.83	0.43	1.58	0.57
Number of comorbidities				
0 (reference)				
Any 1	5.43	3.41	8.63	0.01
3 or more	6.16	3.35	11.32	0.01

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	Included
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Included
Objectives	3	State specific objectives, including any prespecified hypotheses	Included
Methods			
Study design	4	Present key elements of study design early in the paper	Included
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Included
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Included
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Included
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Included
Bias	9	Describe any efforts to address potential sources of bias	Limitations described
Study size	10	Explain how the study size was arrived at	Included
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Included
		(*b*) Describe any methods used to examine subgroups	N/A

			and interactions	
			(*c*) Explain how missing data were addressed	N/A
			(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
			(*e*) Describe any sensitivity analyses	N/A
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed		Included
		(b) Give reasons for non-participation at each stage		
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders		Included
		(b) Indicate number of participants with missing data for each variable of interest		
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)		
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time		
		Case-control study—Report numbers in each exposure category, or summary measures of exposure		
		Cross-sectional study—Report numbers of outcome events or summary measures		Included
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		N/A
		(*b*) Report category boundaries when continuous variables were categorized		
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		Included
Discussion				
Key results	18	Summarise key results with reference to study objectives		Included
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		Included
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence		Included
Generalisability	21	Discuss the generalisability (external validity) of the study results		Included

Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Included

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Epidemiologic Investigation of the First 5,685 Cases of SARS-CoV-2 Infection in Qatar, February 28-April 18, 2020

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Epidemiologic Investigation of the First 5,685 Cases of SARS-CoV-2 Infection in Qatar, February 28-April 18, 2020

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Abstract

Objective

To define the epidemiologic curve of COVID-19 in Qatar and determine factors associated with severe or critical illness

Design

Case series of first 5,685 COVID-19 cases in Qatar

Setting and Participants

All confirmed COVID-19 cases in the State of Qatar between February 28 and April 18, 2020

Main Outcome Measures

Number of total and daily new COVID-19 infections; demographic characteristics and comorbidity burden and severity of infection; factors associated with severe or critical illness

Results

Between February 28 and April 18, 2020, 5,685 cases of COVID-19 were identified. Median age was 34 (IQR 28,43) years, 88.9% were male and 8.7% were Qatari nationals. Overall, 83.6% had no concomitant comorbidity, and 3.0% had 3 or more comorbidities. The overwhelming majority (90.9%) were asymptomatic or with minimal symptoms, with 2.0% having severe or critical illness. Seven deaths were observed during the time interval studied. Presence of hypertension or diabetes was associated with a higher risk of severe or critical illness, but age was not. The epidemiologic curve indicated two distinct patterns of infection, a larger cluster among expatriate craft and manual workers, and a smaller one among Qatari nationals returning from abroad during the epidemic.

Conclusion

COVID-19 infections in Qatar started in two distinct clusters, but then became more widespread in the population through community transmission. Infections were mostly asymptomatic or with minimal symptoms and associated with very low mortality. Severe/critical illness was associated with presence of hypertension or diabetes, but not with increasing age.

Article Summary

Strengths and limitations of this study:

- National study with unified contact tracing and testing
- All testing done at a single lab, and all tests performed in the State of Qatar during the study period were included, providing a robust national estimate of the number of infected persons among those tested
- Comorbidities were retrieved from the electronic medical records using ICD-10 AM codes
- Exact geographic location and contact tracing data were not included in the current report
- It is possible that some persons still under care on the study end date may have progressed to more severe disease after that date

Introduction

A cluster of patients with pneumonia of unknown etiology linked to a seafood wholesale market was first reported from Wuhan, China in December 2019.[1-4] A novel coronavirus, SARS-CoV-2 was isolated as the causative organism and the resultant disease was named COVID-19.[1,5] Initially presumed to be transmitted from animals to humans, the virus has since spread quickly across the globe through human-to-human transmission.[6-9] As of August 20, 2020, more than 22 million cases and over 791,000 deaths have been reported globally. Published epidemiologic studies across a number of populations show significant differences in rates and severity of infection and in case fatality rates.[10] At this stage of a novel virus pandemic, analyzing transmission patterns in populations with unique demographic characteristics can add to our understanding of the disease dynamics. While it is difficult to isolate the effects of public health measures such as quarantine, lockdown, and physical distancing, it is nevertheless useful to track the course of the epidemic in relation to the timeline of their implementation for an understanding of the context in which the epidemic unfolded.

Qatar is a part of the six-country Gulf Cooperation Council (GCC), which also includes Saudi Arabia, Kuwait, Oman, Bahrain and the United Arab Emirates. Qatar has a unique population demographic profile. Among the 2.8 million residents of Qatar, expatriate workforce constitutes about 88% of the population.[11] Due to the nature of the expatriate workforce, the majority of the population in Qatar (~75%) are male, and the population pyramid is heavily concentrated in the 20-50 year age groups, particularly among males.[11] There is evidence that COVID-19 disproportionally affects males and outcomes are poorer in the older age group.[3,12,13] Influx or efflux of the population can also affect epidemic dynamics. Such changes in population can be expected in populations with a high proportion of non-national or non-native groups such as GCC countries. There were no travel restrictions in the early part of the study, i.e. from February 28 to March 30, 2020. A general restriction on all incoming flights into Qatar was implemented

on March 31, which halted almost all influx of visitors or residents into the country. Exit travel was not generally restricted. However, two factors diminished outbound travel sharply: 1) global restrictions on travel leading to a sharp reduction in all flights; 2) restriction of essential workers, e.g. healthcare workers, from taking leave and travelling except in urgent or emergency situations. Our main objective was to define the epidemiologic features of COVID-19 in Qatar, and to determine factors associated with severe or critical illness. Understanding the epidemiology and risk factors for serious infection in Qatar will be important in understanding the epidemiology in countries with unique demographic characteristics.

Methods

Even before the first case of COVID-19 was identified in the country, Qatar had instituted extensive plans to identify and manage persons with COVID-19 infection. The existing tracking, tracing and identification mechanism within the Ministry of Public Health, with proven effectiveness during the MERS-CoV outbreak, was expanded and put on alert.[14,15] Testing for suspected cases started on February 5, 2020, and the first case was recorded on February 28, 2020. Using the Ministry of Public Health national database of COVID-19 patients, we retrospectively identified all confirmed cases of COVID-19 infection between February 28, 2020 and April 18, 2020. All COVID-19 testing in Qatar was performed at the central laboratory of Hamad Medical Corporation, which is the public healthcare delivery arm for the State of Qatar and provides over 85% of the inpatient bed capacity in the State. During the study period, there was targeted, purposeful testing of persons presenting with symptoms of influenza-like illness suggesting COVID-19. For every person who tested positive, active and aggressive contact tracing was carried out by trained staff at the Ministry of Public Health. Nasopharyngeal and throat swabs were collected from suspected cases with symptoms of influenza-like illness suggesting COVID-19 and, if confirmed, from close contacts. Close contacts were identified based on the criteria published by the United States Centers for Disease Control and

Prevention, which define a close contact as “any individual who was within 6 feet of an infected person for at least 15 minutes starting from 2 days before illness onset (or, for asymptomatic patients, 2 days prior to positive specimen collection) until the time the patient is isolated”.[16] Real time RT-PCR was used to detect SARS-CoV-2 infection using TaqPath COVID-19 Combo Kit (Thermo Fisher Scientific, Waltham, Massachusetts) or Cobas SARS-CoV-2 Test (Roche Diagnostics, Rotkreuz, Switzerland). These tests are highly sensitive and specific with no cross-reactivity against multiple other respiratory viruses.[17,18] Nationality of each tested person was ascertained from the official State Identification Card, which is issued to each national and expatriate worker and their dependents residing in Qatar. Demographic characteristics and comorbidities were retrieved from the electronic medical records where they are coded using the International Classification of Diseases 10th edition, Australian Modification. Severity of illness at the time of presentation was determined by expert coders using criteria suggested by the World Health Organization, including admission to an acute care or an intensive care bed, need for mechanical ventilation, oxygen saturation and supplemental oxygen requirement.[19] **(Supplementary table 1)** Severity of illness was categorized into 1) asymptomatic or minimal symptoms, 2) mild symptoms or uncomplicated upper respiratory tract infection without clinical or radiographic evidence of pneumonia, 3) mild symptoms with clinical or radiographic evidence of pneumonia, 4) severely ill, and 5) critically ill.[19]

We created a timeline of newly diagnosed cases to study the progression of the epidemic in Qatar. Key governmental decisions taken by the Supreme Committee for Crisis Management and the Council of Ministers in response to the epidemic were marked on the timeline to show their temporal relation to the cases. Multivariable logistic regression was used to determine factors associated with severe and critical illness. Covariates of interest included in the model were age, gender, nationality and presence of comorbidities. Comorbidities with a total count of less than 15 were excluded because of the small numbers.

Changes in population movement were assessed using Google mobility reports, a publicly available tool that tracks movement of people who use mobile applications like Google Maps.[20] They show changes in visits and length of stay at various locations compared to a baseline. Baseline was the median value, for the corresponding day of the week, during the 5-week period between January 3, 2020 and February 6, 2020.[20]

Ethical Approval

The Institutional Review Board at Hamad Medical Corporation approved this study with an expedited status due to the emergency pandemic status of the COVID-19 outbreak.

Patient and Public Involvement

This study was conducted in response to a national and global public health emergency. There was no patient or public involvement. However, key elements of the data are shared with the public on a daily basis.

Results

Between February 5, 2020 and April 18, 2020 (11:00 AM local time), 60,645 persons were tested for SARS-CoV-2, of whom 5,685 were confirmed positive. Before the first case was diagnosed, testing for SARS-CoV-2 focused on those with influenza-like illness and severe acute respiratory infection. The first cases were identified among quarantined travelers returning to Qatar on February 28, 2020, followed by the identification of a large cluster of over 300 infections on March 6, 2020 among expatriate craft and manual workers. Following the discovery of the first community cluster, testing was expanded to include contacts of new cases, persons in hotspots, that is areas where infections were diagnosed, individuals with suspected infection or suggestive symptoms, and travelers coming or returning to Doha. The rapid

expansion of testing created a backlog, which was resolved through an investment in testing infrastructure that significantly increased the testing capacity to approximately 4,000 tests per day in the early days of the pandemic.

The number of new cases diagnosed by date of diagnosis is presented in **figure 1.** The epidemiologic curve showed two distinct patterns of infection transmission. A larger and sustained community transmission was observed among expatriate workers, predominantly among craft and manual workers, which subsequently reached other population segments. A second smaller cluster among Qatari nationals returning from overseas during the study period was not sustained over time. Subsequent smaller case clusters among Qatari nationals were traced to the local community. The number of tests performed per day and the number testing positive is provided in **supplementary figure 1.** The positivity rate, that is number of tests positive over total number of tests, is shown in **figure 2**. The positivity rate increased steadily with time, with somewhat of an accelerated rate after April 5, 2020.

The median age (IQR) of the infected persons was 34 (28,43) years and 88.9% were male **(Table 1).** Other baseline characteristics are also shown in **table 1.** The nationalities with highest frequency of infection were Indian (27.4%), Bangladeshi (18.9%), Nepalese (18.4%), Qatari (8.7%), and Pakistani (6.2%). The most common comorbidities were hypertension (6.9%), diabetes mellitus (6.0%), cardiovascular disease (4.4%) and chronic lung disease (3.0%). Comorbidity data were missing for 235 persons (4.1%). Among all infected persons, 4,753 (83.6%) had no known comorbidity and 697 (12.3%) had at least one comorbidity. An overwhelming majority of infected persons (90.9%) were either asymptomatic or had minimal symptoms, 0.8% had mild illness without evidence of pneumonia, 2.3% had mild illness with pneumonia, and 2% were severe or critically ill. Severity of illness data were missing for 223 (3.9%) persons. **(Table 1)** Since age is a critical determinant of outcomes in patients with

SARS-CoV-2 infecion, we looked at age with multiple different groupings and ranges. Among those aged 0-10, only 3 out of 121 children had mild upper respiratory symptoms without evidence of pneumonia; all others were asymptomatic. Among those aged 11-15, none of the 44 children were symptomatic. Among those aged 16-18, 1 had mild upper respiratory symptoms without evidence of pneumonia and 2 had severe disease. There were no incidence of critical illness and no deaths in children. These numbers were too low for each of those age categories to be entered into a regression model, therefore we grouped ages 0-20 years together.

A larger proportion of persons with mild illness with or without pneumonia and those with severe or critical illness had at least one comorbidity. **(Table 2)** Compared to those with asymptomatic or minimally symptomatic illness, prevalence of most comorbidities was 3-4 times higher among those with mild disease with or without pneumonia or severe/critical illness. Severity of illness by number of comorbidities is shown in **table 3.** Among persons with no comorbidity, 96.1% were asymptomatic or had minimal symptoms, 2.5% had mild illness with or without pneumonia, and 1.4% were severely or critical ill. Among persons with 2 or more comorbidities, 82.1% were asymptomatic or had minimal symptoms, 10.9% had mild illness with or without pneumonia, and 7.1% were severely or critical ill. **(Table 3)**

Seven deaths were observed during the time interval studied, corresponding to a case-fatality rate of 1.2 per 1,000 cases. All seven deaths were males aged 40-88 years. All except one (74 years old male) had comorbidities, including diabetes (5 subjects), cardiovascular disease (5 subjects) and hypertension (3 subjects). One patient (58 years old male) had 5 comorbidities (diabetes, hypertension, cardiovascular disease, chronic kidney and liver disease). In a multivariable logistic regression model, presence of hypertension (OR 3.49; 95% CI 1.83,6.68) or diabetes (OR 3.17; 95% CI 1.76,5.71) were associated with a higher risk of severe or critical

disease. **(Table 4)** Cardiovascular disease, chronic lung disease, chronic kidney disease and solid organ malignancy were not associated with a higher risk. We repeated the logistic regression analysis after excluding those with missing data and the results were nearly identical. **(Supplementary table 2)** We also repeated the analysis using number of comorbidities as covariates. Presence of any single comorbidity (OR 5.43, 95% CI 3.41,8.63) or any 3 or more comorbidities (OR 6.16, 95% CI 3.35,11.32) were associated with a higher risk of severe or critical illness. **(Supplementary table 3)**

In a subsequent report in which the first 5,000 patients with COVID-19 infection in Qatar were followed for up to 60 days after diagnosis, a total of 1,424 patients (28.5%) required hospitalization, out of which 108 (7.6%) were admitted to an intensive care unit (ICU), 14 patients (0.28%) had died, 10 (0.2%) were still in hospital, and two (0.04%) were still in ICU.[21]

Google mobility reports data demonstrated a significant decrease in number of people visiting retail and recreation outlets, grocery and pharmacy stores, parks, transit stations and workplaces over time. **(Table 5)** A concurrent increase in people staying in residential areas was observed over this timeframe. A snapshot on April 17 showed a 69% reduction in visits to retail and recreation areas, a 44% reduction in visits to grocery and pharmacy stores, a 64% decrease in visits to parks, a 68% decrease in visits to transit stations and a 38% decrease in visits to workplaces. A 21% increase in people in residential areas was observed on this date.

Discussion

We provide a characterization of the SARS-CoV-2 outbreak in Qatar, which offers new insights into the behavior of the pandemic in a unique demographic setting.

The first case in Qatar was identified on February 28, 2020, among returning travelers, which is nearly 9 weeks after the first cluster was reported from Wuhan, China.[22] During this time, infection had spread to multiple countries over four continents. This was also a critical time during which the State of Qatar formulated a national plan to respond to the anticipated cases. Testing for SARS-CoV-2 started in Qatar on February 5, 2020 and the first major cluster of cases was identified on March 8, 2020 where over 300 cases were linked to 4 expatriate workers through aggressive contact tracing. Such aggressive identification and contact tracing and testing were probably the reasons for a small number of daily new cases till March 31, 2020. At that time, a large number of returning travelers and nationals were identified to have infection. The number of daily diagnosed infections accelerated in April, in part due to a large increase in number of daily tests, but also reflecting expansion of the epidemic in the wider population. This trend occurred predominantly in expatriate workers often living in more crowded areas and accommodations with frequent social mixing despite a national campaign to discourage peoples' movement except in urgent situations. The epidemic, however, eventually reached a larger population.

An overwhelming majority (>90%) of confirmed COVID-19 cases were asymptomatic or had minimal symptoms not requiring urgent medical care or hospitalization. This is likely due to the younger age of the population (median age 34 years) and overall absence of any comorbidities in the vast majority of the infected persons. This reinforces our current understanding of the disease being mild or asymptomatic in a majority of the persons, particularly among the younger and healthier persons, as well as the strong role of age in the epidemiology of this infection. Similar to other studies, presence of comorbidities was associated with severe or critical disease.[1] We found a very low mortality among confirmed COVID-19 patients in Qatar, which may at least partly be attributable both to the timely and effective response of the health system and the demographic characteristics of the infected persons. It is conceivable that right

censoring with the time delay between onset of disease to death may play a part, though similarly very low mortality after the study period ended does not support this. The role that factors such as free access to high quality medical care for everyone residing in Qatar, availability of a high number of critical care beds, or differences in viral subtypes, played, needs further study.

In response to the spread of COVID-19, the country took a series of public health measures, including limiting incoming passenger flights into Doha through Hamad International Airport and providing free state quarantine facilities for returning travelers. A host of other measures were implemented gradually that promoted physical distancing, including closing retail stores in malls and shopping centers, closing entertainment and dining facilities, postponing or canceling large sports events and conferences, suspending classes in schools and universities, and mandating working from home for 80% of workers in the public and private sectors. The healthcare system was also reorganized to prioritize COVID-19 response over routine services. All positive cases including those without symptoms were admitted to isolation facilities managed by the public healthcare system. These public health measures were heavily promoted and widely communicated through social and traditional media outlets to all segments of society. Mobility data shows a significant reduction in visits to common retail, recreation, transit and workplace areas, which may have contributed to a reduction in spread of infection. There was a more pronounced reduction in mobility in the weeks following April 5th, which coincides with the significant rise in the reported number of positive cases.

The pandemic has affected nearly every country and territory in the world. However, infection rates and case fatality rates vary widely among countries. For example, crude case fatality rate is 3.2% in the US, 7.5% in Canada, 15% in the UK, but only 0.16% in Qatar and 0.67% in Kuwait (as of August 10, 2020).[23] It has been postulated that the population demographics and

comorbidity burden are the key determinants of the variability in case fatality rates. However, these differences alone are unlikely to fully account for the widely variable case fatality rates. Testing per capita, seroprevalence among the general population, availability of acute and intensive care beds, living arrangements of infected persons and access to promising therapeutic options may provide additional explanations for the difference.

Strengths of our study include unified contact tracing and testing, with all testing done at a single lab. All tests performed in the State of Qatar were included, providing a robust national estimate of the number of infected persons among those tested. There are limitations to our study. Comorbidities were retrieved from the electronic medical records using ICD-10 AM codes. Exact geographic location and contact tracing data were not included in the current report. Our study end date was April 18, 2020, and all persons with confirmed infection till that date were included. However, it is possible that some persons may have progressed to more severe disease after this date. Some of these data are the subject of another report with a brief summary provided in the preceding paragraph. Finally, the testing for COVID-19 during the study period was not population based which may affect the true infection rates and outcomes.

In conclusion, we describe the evolution of COVID-19 epidemic in the State of Qatar. For the population tested, the epidemic predominantly affected males and younger population and was associated with no or minimal symptoms in a vast majority of the infected persons. Presence of hypertension and diabetes were associated, but increasing age was not associated with a higher risk of severe or critical illness. Public health measures were instituted early and may have led to the slower growth compared with other countries which delayed such measures.

Table 1. Characteristics of 5,685 patients with confirmed COVID-19 infection in Qatar between February 29 and April 18, 2020.

Variable	**N (%)**
Demographics	
Mean age, years (SD)	35.8 (12.0)
Median age, years (IQR)	34 (28,43)
0-20 years	302 (5.3%)
21-40 years	3,666 (64.5%)
41-60 years	1,537 (27.0%)
>60 years	180 (3.2%)
Male sex	5,052 (88.9%)
Nationality	
Indian	1,559 (27.4%)
Bangladeshi	1,077 (18.9%)
Nepalese	1,047 (18.4%)
Qatari	497 (8.7%)
Pakistani	353 (6.2%)
Filipino	185 (3.3%)
Egyptian	179 (3.1%)
Sri Lankan	109 (1.9%)
Sudanese	91 (1.6%)
Others	588 (10.3%)
Comorbidities	
Hypertension	391 (6.9%)
Diabetes mellitus	344 (6.0%)

Cardiovascular disease	250 (4.4%)
Chronic lung disease	169 (3.0%)
Chronic kidney disease	35 (0.6%)
Solid organ malignancy	30 (0.5%)
Tuberculosis	13 (0.2%)
Chronic liver disease	12 (0.2%)
Autoimmune disease	6 (0.1%)
Missing	235 (4.1%)
Number of comorbidities (235 missing)	
0	4,753 (83.6%)
1	384 (6.8%)
2	139 (2.5%)
3	121 (2.1%)
≥4	53 (0.9%)
Missing	235 (4.1%)
Severity of illness	
Asymptomatic or minimal symptoms	5,168 (90.9%)
Mild illness without pneumonia	44 (0.8%)
Mild illness with pneumonia	133 (2.3%)
Severe illness	82 (1.4%)
Critical illness	35 (0.6%)
Missing	223 (3.9%)

Table 2. Prevalence of comorbidities by severity of illness.

	Asymptomatic or minimally symptomatic N (%)	Mild illness with or without pneumonia N (%)	Severe/critical illness N (%)
Hypertension	317 (6.1)	41 (23.2)	31 (26.5)
Diabetes mellitus	281 (5.4)	33 (18.6)	30 (25.6)
Cardiovascular disease	199 (3.8)	31 (17.5)	19 (16.2)
Chronic lung disease	145 (2.8)	12 (6.8)	10 (8.6)
Chronic kidney disease	25 (0.5)	6 (3.4)	4 (3.4)
Solid organ malignancy	26 (0.5)	2 (1.1)	2 (1.7)
Tuberculosis	10 (0.2)	2 (1.1)	1 (0.8)
Chronic liver disease	10 (0.2)	2 (1.1)	0 (0)
Autoimmune disease	5 (0.1)	1 (0.6)	0 (0)

Table 3.Severity of illness by number of comorbidities

Number of comorbidities	Asymptomatic or minimal symptoms, N (%)	Mild illness with or without pneumonia, N (%)	Severe/critical illness, N (%)
No comorbidity	4,582 (96.1%)	120 (2.5%)	67 (1.4%)
Only 1 comorbidity	330 (86.6%)	23 (6.0%)	28 (7.3%)
2 or more comorbidities	256 (82.1%)	34 (10.9%)	22 (7.1%)

Table 4. Factors associated with severe or critical illness (multivariable logistic regression model).

Variables	Odds Ratio	[95% Conf. Interval]		P-value
Age				
0-20 years (reference)	reference			
21-40 years	1.51	0.46	4.93	0.62
41-60 years	1.57	0.45	5.46	0.55
60+ years	1.39	0.3	6.49	0.94
Male gender	0.98	0.53	1.83	0.95
Qatari nationality (vs. non-Qatari)	0.83	0.43	1.6	0.58
Hypertension	3.49	1.83	6.68	0.0002
Diabetes mellitus	3.17	1.76	5.71	0.0001
Cardiovascular disease	0.54	0.24	1.22	0.14
Chronic lung disease	1.64	0.79	3.42	0.19
Chronic kidney disease	1.31	0.41	4.21	0.65
Cancer	1.26	0.28	5.66	0.77

Table 5. Relative change in people visiting areas of common interest in the State of Qatar.

(Comparison period January 3, 2020 – February 6, 2020)

	Qatar March 29	Qatar April 5	Qatar April 11	Qatar April 17
Retail & Recreation	-51%	-50%	-63%	-69%
Grocery & Pharmacy	-25%	-21%	-35%	-44%
Parks	-34%	-35%	-48%	-64%
Transit stations	-52%	-52%	-60%	-68%
Workplaces	-31%	-36%	-39%	-38%
Residential	+22%	+24%	+23%	+21%

Figure 1. Epidemiologic curve of patients with COVID-19 in Qatar.

Figure 2. Positivity rate among those tested for SARS-CoV-2 active infection by swab day.

Contributorship Statement:

Drafting of the manuscript: HMAK; HFAR; LJAR; RB; AAB;

Data acquisition: AAB; AAK; MHAT; ANL; ZAK; SAM; HEA; RO; MAM; ABAS;

Laboratory testing and reporting: EAK; PC;

Study design: HMAK; HFAR; LJAR; RB; AAB;

Data analysis: AAB;

Data interpretation: HMAK; AAB; HFAR; LJAR; RB;

Critical appraisal and review: All authors

Competing interests:

None of the authors have any financial conflict of interest related to this article.

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Funding

None

Data Sharing Statement

No additional data are available

Ethical Approval

This study was approved by the Institutional Review Board at Hamad Medical Corporation.

(MRC-05-011)

Patient Consent

A waiver of informed consent was granted.

Patient of Public Involvement

There was not patient or public involvement in the design, conduct or reporting of this study.

Transparency declaration

The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

Dissemination declaration

Dissemination to study participants or patient organizations is not possible/applicable.

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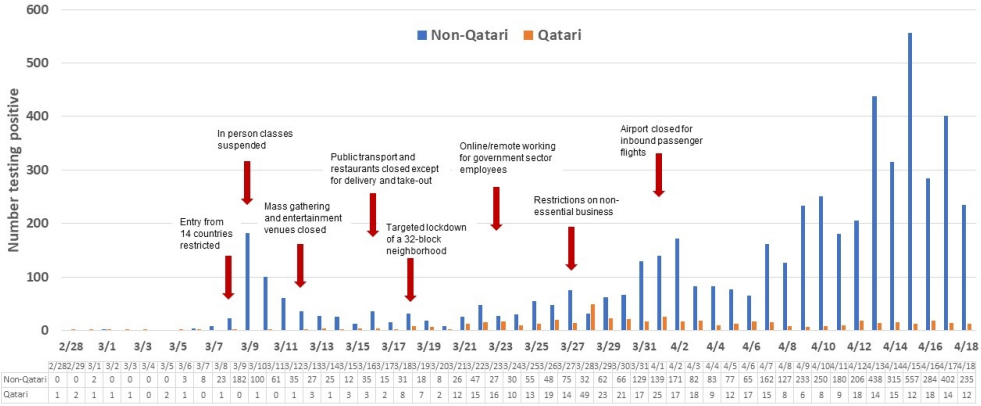


	2/28	2/29	3/1	3/2	3/3	3/4	3/5	3/6	3/7	3/8	3/9	3/10	3/11	3/12	3/13	3/14	3/15	3/16	3/17	3/18	3/19	3/20	3/21	3/22	3/23	3/24	3/25	3/26	3/27	3/28	3/29	3/30	3/31	4/1	4/2	4/3	4/4	4/5	4/6	4/7	4/8	4/9	4/10	4/11	4/12	4/13	4/14	4/15	4/16	4/17	4/18
Non-Qatari	0	0	2	0	0	0	0	3	8	23	182	100	61	35	27	25	12	35	15	31	18	8	26	47	27	30	55	48	75	32	62	66	129	139	171	82	83	77	65	162	127	233	250	180	206	438	315	557	284	402	235
Qatari	1	2	1	1	1	0	2	1	0	1	0	1	0	1	3	1	3	3	2	8	7	2	12	15	16	10	13	19	14	49	23	21	17	25	17	18	9	12	17	15	8	6	8	9	18	14	15	12	18	14	12

Figure 1

54x30mm (600 x 600 DPI)

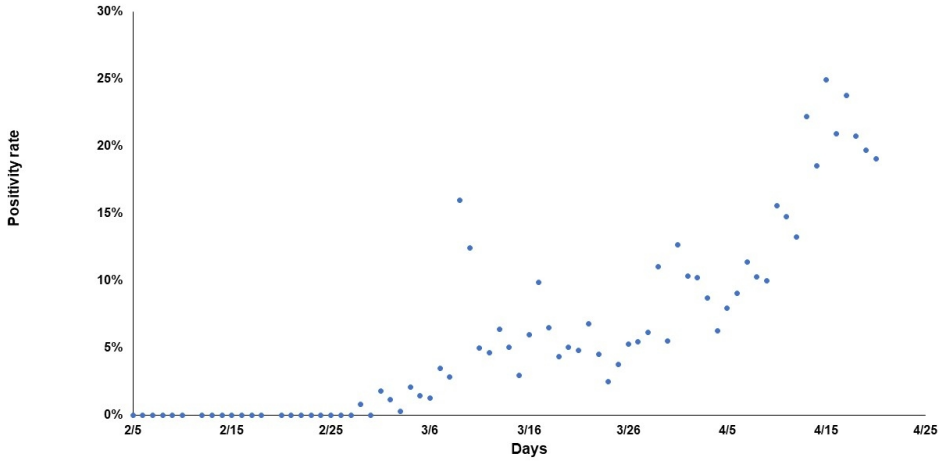
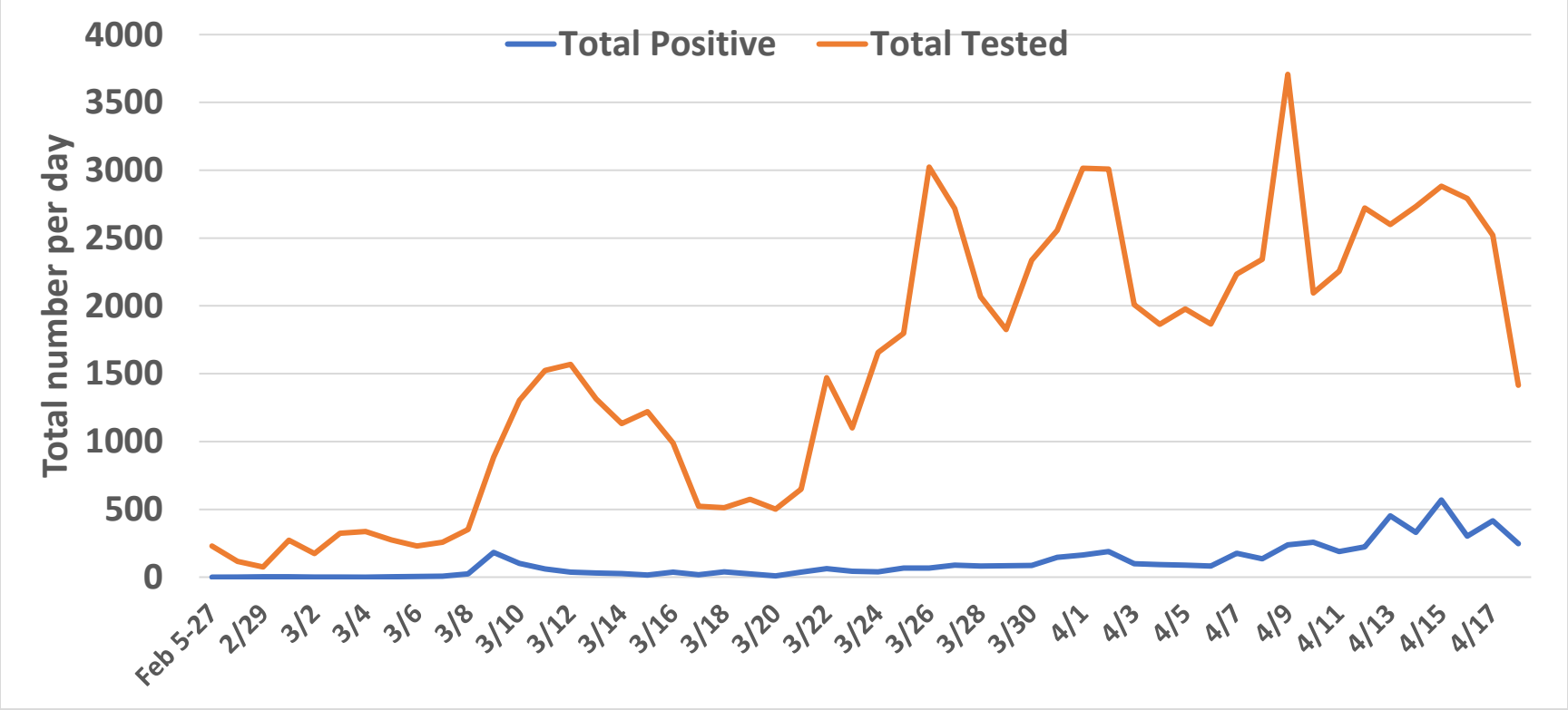


Figure 2

54x30mm (600 x 600 DPI)

Supplementary figure. Number of tests done and number of persons who tested positive per day.



Supplementary table. World Health Organization definitions of severity of illness in persons with COVID-19 infection.

Category		Definition
Mild		Patients with uncomplicated upper respiratory tract viral infection, may have non-specific symptoms such as fever, fatigue, cough (with or without sputum production), anorexia, malaise, muscle pain, sore throat, dyspnea, nasal congestion, or headache. Rarely, patients may also present with diarrhoea, nausea and vomiting. The elderly and immunosuppressed may present with atypical symptoms. Symptoms due to physiologic adaptations of pregnancy or adverse pregnancy events, such as e.g. dyspnea, fever, GI-symptoms or fatigue, may overlap with COVID-19 symptoms.
	Pneumonia	Adult with pneumonia but no signs of severe pneumonia and no need for supplemental oxygen. Child with non-severe pneumonia who has cough or difficulty breathing + fast breathing: fast breathing (in breaths/min): < 2 months: ≥ 60; 2–11 months: ≥ 50; 1–5 years: ≥ 40, and no signs of severe pneumonia.
Severe	Severe pneumonia	Adolescent or adult: fever or suspected respiratory infection, plus one of: respiratory rate > 30 breaths/min; severe respiratory distress; or SpO2 ≤ 93% on room air. Child with cough or difficulty in breathing, plus at least one of the following: central cyanosis or SpO2 < 90%; severe respiratory distress (e.g. grunting, very severe chest indrawing); signs of pneumonia with a general danger sign: inability to breastfeed or drink, lethargy or unconsciousness, or convulsions. Other signs of pneumonia may be present: chest indrawing, fast breathing (in breaths/min): < 2 months: ≥ 60; 2–11 months: ≥ 50; 1–5 years: ≥ 40. While the diagnosis is made on clinical grounds; chest imaging may identify or exclude some pulmonary complications.
Critical	Acute respiratory distress syndrome	Onset: within 1 week of a known clinical insult or new or worsening respiratory symptoms. Chest imaging (radiograph, CT scan, or lung ultrasound): bilateral opacities, not fully explained by volume overload, lobar or lung collapse, or nodules. Origin of pulmonary infiltrates: respiratory failure not fully explained by cardiac failure or fluid overload. Need objective assessment (e.g. echocardiography) to exclude hydrostatic cause of infiltrates/oedema if no risk factor present. Oxygenation impairment in adults: Mild ARDS: 200 mmHg < PaO2/FiO2 ≤ 300 mmHg (with PEEP or CPAP ≥ 5 cmH2O, or non-ventilated) Moderate ARDS: 100 mmHg < PaO2/FiO2 ≤ 200 mmHg (with PEEP ≥ 5 cmH2O, or non-ventilated) Severe ARDS: PaO2/FiO2 ≤ 100 mmHg (with PEEP ≥ 5 cmH2O, or non-ventilated) When PaO2 is not available, SpO2/FiO2 ≤ 315 suggests ARDS (including in non-ventilated patients).

		Oxygenation impairment in children: note OI = Oxygenation Index and OSI = Oxygenation Index using SpO2. Use PaO2-based metric when available. If PaO2 not available, wean FiO2 to maintain SpO2 ≤ 97% to calculate OSI or SpO2/FiO2 ratio: Bilevel (NIV or CPAP) ≥ 5 cmH2O via full face mask: PaO2/FiO2 ≤ 300 mmHg or SpO2/FiO2 ≤ 264 Mild ARDS (invasively ventilated): 4 ≤ OI < 8 or 5 ≤ OSI < 7.5 Moderate ARDS (invasively ventilated): 8 ≤ OI < 16 or 7.5 ≤ OSI < 12.3 Severe ARDS (invasively ventilated): OI ≥ 16 or OSI ≥ 12.3.
	Sepsis	Adults: life-threatening organ dysfunction caused by a dysregulated host response to suspected or proven infection.[1] Signs of organ dysfunction include: altered mental status, difficult or fast breathing, low oxygen saturation, reduced urine output, fast heart rate, weak pulse, cold extremities or low blood pressure, skin mottling, or laboratory evidence of coagulopathy, thrombocytopenia, acidosis, high lactate or hyperbilirubinemia. Children: suspected or proven infection and ≥ 2 aged based systemic inflammatory response syndrome criteria, of which one must be abnormal temperature or white blood cell count.
	Septic shock	Adults: persisting hypotension despite volume resuscitation, requiring vasopressors to maintain MAP ≥ 65 mmHg and serum lactate level > 2 mmol/L. Children: any hypotension (SBP < 5th centile or > 2 SD below normal for age) or two or three of the following: altered mental state; tachycardia or bradycardia (HR < 90 bpm or > 160 bpm in infants and HR < 70 bpm or > 150 bpm in children); prolonged capillary refill (> 2 sec) or feeble pulse; tachypnea; mottled or cool skin or petechial or purpuric rash; increased lactate; oliguria; hyperthermia or hypothermia.

Supplementary table 2. Factors associated with severe or critical illness after excluding those with missing severity of illness data (multivariable logistic regression model).

Variables	Odds Ratio	[95% Conf. Interval]		P-value
Age				
0-20 years (reference)	reference			
21-40 years	1.51	0.46	4.93	0.62
41-60 years	1.57	0.45	5.43	0.55
60+ years	1.40	0.30	6.55	0.94
Male gender	0.98	0.53	1.83	0.95
Qatari nationality (vs. non-Qatari)	0.83	0.43	1.60	0.58
Hypertension	3.48	1.82	6.66	0.0002
Diabetes mellitus	3.14	1.74	5.65	0.0001
Cardiovascular disease	0.55	0.24	1.22	0.14
Chronic lung disease	1.65	0.79	3.43	0.19
Chronic kidney disease	1.31	0.41	4.21	0.65
Cancer	1.25	0.28	5.65	0.77

Supplementary table 3. Factors associated with severe or critical illness by number of comorbidities (multivariable logistic regression model).

Variables	Odds Ratio	[95% Conf. Interval]		P-value
Age				
0-20 years (reference)				
21-40 years	1.42	0.43	4.67	0.75
41-60 years	1.49	0.43	5.19	0.65
60+ years	1.44	0.31	6.66	0.84
Male gender	0.96	0.51	1.78	0.89
Qatari nationality (vs. non-Qatari)	0.83	0.43	1.58	0.57
Number of comorbidities				
0 (reference)				
Any 1	5.43	3.41	8.63	0.01
3 or more	6.16	3.35	11.32	0.01

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5 & 6
Methods			
Study design	4	Present key elements of study design early in the paper	6-8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6-8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-8
Bias	9	Describe any efforts to address potential sources of bias	14
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	N/A
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-8
		(*b*) Describe any methods used to examine subgroups and interactions	N/A

		(*c*) Explain how missing data were addressed	N/A
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	N/A
		(*e*) Describe any sensitivity analyses	N/A
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6-8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	9-11
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	9-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	N/A
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10-11
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	14
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14
Other information			

Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	23

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.