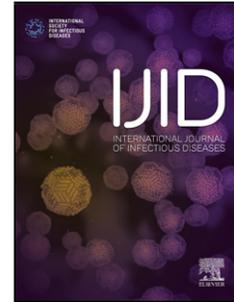


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# **Severe Acute Respiratory Syndrome (SARS) and Coronavirus disease-2019 (COVID-19): From Causes to Preventions in Hong Kong**

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## **Highlights**

- Hong Kong has been attacked by the coronavirus disease-2019 (COVID-19).
- To prevent further outbreak of COVID-19, this article discusses the current understanding of COVID-19 and compares with the outbreak of SARS-CoV-2 in 2003 of Hong Kong.
- The cause, transmission, symptoms, diagnosis, treatment and prevention to study for an applicable measurement to control COVID-19.

## **Abstract**

Hong Kong has been recently attacked by the coronavirus disease-2019 (COVID-19). In late January 2020, it's shown a steadily increasing trend of confirmed cases. There is a 257 in total infected cases confirmed including 4 deaths until 20<sup>th</sup> of March 2020. To prevent further outbreak of COVID-19, this article discusses the current understanding of COVID-19 and compares with the outbreak of SARS-CoV-2 in 2003 of Hong Kong from the causes, transmission, symptoms, diagnosis, treatments and preventions to study for an applicable measurement to control COVID-19.

Keywords: Severe Acute Respiratory Syndrome (SARS); Coronavirus disease-2019 (COVID-19); Causes; Transmissions; Symptoms; Diagnosis; Treatments; Preventions; Hong Kong

## Introduction

An outbreak of pneumonia with unknown etiology emerged in Wuhan of Hubei Province, China on December in 2019. Chinese scientists confirmed that a new coronavirus named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is the cause of pneumonia outbreak. Now, this severe acute respiratory syndrome has been termed as coronavirus disease 2019 (COVID-19) by the World Health of Organization (WHO) [1].

Coronavirus is a group of viruses categorized into alphacoronavirus and betacoronavirus often causing cold and other mild upper respiratory tract infections in the human body.

Alphacoronavirus consists of HCoV-229E and HCoV-NL63; Betacoronavirus consists of HCoV-OC43 and HCoV-HKU1. Nevertheless, the rare form would be lethal such as SARS, MERS and COVID-19 [2]. SRAS-CoV, MERS-CoV and SARS-CoV-2 are betacoronavirus [3]. However,

SARSr-CoVs belong to the subgenus Sarbecovirus (previously lineage B) of genus Betacoronavirus and occupy a unique phylogenetic position. It's the most lethal [4].

On the 20<sup>th</sup> of March 2020, 178 countries or territories reported that there are 234073 in the total confirmed case with 9840 deaths globally; 81300 confirmed cases and 3253 deaths reported in China [5]; 257 confirmed case with 4 deaths in Hong Kong [6]. In response to the outbreak, we summarize the current knowledge of COVID-19 and compare it with the previous experiences of the SARS outbreak in Hong Kong to study for an effective measurement to control the COVID-19 epidemic.

## Causes

**SARS** was caused by a coronavirus (CoV) and identified in 2003 according to the World Health Organization (WHO). Coronavirus (CoV) is an animal virus from bats which infected human in Guangdong province, China [7-8].

Hong Kong's SARS index-patient was Dr. LIU Jianlun in February 2003, who came to attend a family wedding gathering. He was a Provinciale doctor contacting and treating SARS patients from Sun Yat-Sen Memorial Hospital in Guangdong [9]. On 21<sup>st</sup> of February 2003, Dr. LIU and his wife checked into room 911 on the 9<sup>th</sup> floor of Metropole Hotel in Kowloon Hong Kong. He was a SARS super-spreader infected 23 other hotel guests from 7<sup>th</sup> to the 9<sup>th</sup> floor. The hotel guests traveled to Canada, Singapore, Taiwan and Vietnam transmitting SARS to these locations. Dr. LIU was hospitalized in Kwong Wah Hospital of Hong Kong, he never recovered and died in the Intensive Care Unit on 4<sup>th</sup> of March, while he caused around 80% of the Hong Kong cases [10-11].

**COVID-19** is similar to SARS, also caused by a coronavirus (CoV) that occurred in the seafood and wet animal wholesale market in Wuhan, Hubei Province, China [12-13].

On 22<sup>th</sup> of January 2020, the first COVID-19 case was confirmed in Hong Kong and announced by the Centre of Health Protection (CHP). However, no index patient has been identified at present. Initially, most of the confirmed cases had a travel history to Mainland China by High-Speed Rail, especially from Wuhan. Only a confirmed case had no recent travel history on 5<sup>th</sup> of February 2020 [14-20]. There was an increase in the largest number of 10 confirmed cases per day from 9<sup>th</sup> of February 2020. In the Chinese lunar new year family gathering with two relatives from Guangdong Province, China [21]. 11 of 19 participants were diagnosed with COVID-19 infection. 2 other confirmed cases were the colleagues of the infected participants [22-24]. Besides, the largest community spreading was reported at Fook Wai Ching She from Maylun Apartments in North Point Hong Kong on 4<sup>th</sup> of March. 18 patients in total were tested with a positive result of COVID-19 who's visited the temple or association with the confirmed cases in January or February [20]. The accumulated number of cases was raised to 257 with a steadily increasing number of infected cases in Hong Kong on 20<sup>th</sup> of March 2020 [6].

### **The trend of SARS outbreak**

A total of 1718 infected cases appeared in Hong Kong from 11<sup>th</sup> of March to 6<sup>th</sup> of June 2003 [25]. The SARS epidemic had three phases from March to June. First, the outbreak in Prince Wales Hospital was in March because of the local infected person admission while the spreading of SARS infection affected a large number of medical staffs and students; Second outbreak related to the spread from hospital to the community on 15<sup>th</sup> of April 2003 which influenced block E of Amoy Garden with a total 329 estate residents infected cases; Third phase was from

the early of May to the mid of June 2003, continuous new cases were reported but in a declining trend. According to the previous studied, SARS induced 253 dead in Hong Kong [26], it was approximately 15% dead rate ranging from 1% in those aged less than 24 years to over 50% in those aged over 65 years within this period [27].

### **The trend of COVID-19 outbreak**

In Hong Kong, there were 257 infected cases from 23<sup>th</sup> of January to 20<sup>th</sup> of March 2020. It consisted of 140 males and 117 females within ten age groups from 0 to 100 years old. The age and gender distribution of infected patients were shown in Figure 1 [6].

The identity of confirmed cases were divided into three categories, 9 (3%) person of unknown (waiting for confirmation), 10 (4%) of Non-Hong Kong residents and 238 (93%) of Hong Kong residents (Figure 2) [6].

There were only a few infection cases from 23<sup>th</sup> of January to 8<sup>th</sup> of February. However, the infection cases rose quickly on the 9<sup>th</sup> of February as the Hong Kong boundary control points such as Lo Wu, Lok Ma Chau, Lok Ma Chau Spur Line and Macau Ferry Terminal were not closed at the beginning for reducing the flow of people and traffic [28]. The reported cases were increased sharply from 23<sup>rd</sup> of January to 20<sup>th</sup> of March especially after 17<sup>th</sup> of March which was double per day (Figure 3) possibly because some Hong Kong residents returned to Hong Kong from overseas countries with infected COVID-19 [6].

On 12<sup>th</sup> of February, the first infected person was discharged and the accumulated discharged persons were 97 at present (Figure 4).

### **Transmission**

**SARS-CoV** is most readily transmitted by respiratory droplets when an infected person coughs or sneezes within a short distance. The virus could also spread when a person touches a surface or object contaminated with infectious droplets then touched his/her mouth, nose or eyes [29]. The average incubation period for SARS within human is 4 to 6 days, although rarely it can be as short as 1 day or as long as 14 days [30]. SARS patients secrete the virus excretion in respiratory and stool during the second week of illness and start to deteriorate. It resulted in more than 8000 persons suffered from Severe Acute Respiratory Syndrome (SARS) and caused 774 person's death in 2002-2003 [31].

**SARS-CoV-2** was indicated as animal-to-human transmission because of the linkage between fish and wild animal market based on the early studied [32]. However, there is a rapidly increasing incidence of infections by asymptomatic carriers [33-34], therefore, SARS-CoV-2 may have human-to-human transmission through droplets or direct contact [35-36].

Compared to SARS-CoV, SARS-CoV-2 might be transmitted by respiratory droplets within a long distance of 2m or by contaminated surfaces leading to infection through contact transmission [1]. The average incubation period for COVID-19 expands to 5 days and the period of quarantine is 14 days from the last date of exposure. It was the longest incubation period for similar types of coronaviruses. However, it's remained argumentative since the longest incubation period for COVID-19 can be 27 days or above according to the present-day finding [37]. Perhaps, respiratory droplets were not the major factor for transmission [38]. Recently, there is a patient dog infected from its nasal and oral cavity with a low level of COVID-19 virus. It's not shown any signs of disease before. This is the first case of human-to-animal transmission that has been confirmed by the experts from School of Public Health in the Hong Kong

University, College of Veterinary Medicine & Life Sciences in the City University of Hong Kong and the World Organization for Animal Health [39].

## **Symptoms**

The symptoms of SARS and COVID-19 are divided into systematic and respiratory disorders (Table 1). Systematic disorders of SARS and COVID-19 are fever, cough and fatigue. The major respiratory disorders of COVID-19 and SARS are rhinorrhea, sneezing, sore throat and pneumonia but COVID-19 patients have more respiratory symptoms than the patients with SARS [29, 34, 40-42]. Leukopenia, lymphopenia and lower platelet count are possibly observed in the hematology [43-44].

## **Diagnosis**

Reverse transcription polymerase chain reaction (RT-PCR) is the golden test for the diagnosis of SARS and COVID-19. Computed Tomography (CT) scan is the auxiliary diagnostic method. The images of CT sometimes appear bilateral pulmonary parenchymal ground-glass and consolidative pulmonary opacities with a rounded morphology and a peripheral lung distribution when patients infected with SARS and COVID-19 [45].

## **SARS**

RT-PCR is a technique that combines RNA reverse transcription with polymerase chain amplification (PCR) of cDNA. It's the rapid and specific diagnostic test for SARS following the protocols of the World Health Organization (WHO) and commonly used in the SARS outbreak 2003. Respiratory specimen, stool specimen and urine specimen could be used for RT-PCR testing while respiratory specimens were collected in the SARS epidemic [46]. The peak

detection period in SARS-CoV after illness: respiratory specimen is week 2; stool and rectal swab specimens are weeks 2 to 3 and urine specimen is week 4 [21].

## **COVID-19**

Real-time quantitative polymerase chain reaction (RT-qPCR) is the most common and effective nucleic acid detection technologies for SARS-CoV-2. Meanwhile, high-throughput sequencing technology has been applied for diagnosis. It's limited usage because of the high cost. Immune identification technologies such as Point-of-care Testing (POCT) of IgM/IgG and enzyme-linked immunosorbent assay (ELISA) are other possible diagnostic methods for COVID-19 but remain to be studied [45].

## **Treatments**

### **SARS**

The combination regimen of steroids and ribavirin was the treatment protocols for SARS in Hong Kong [47].

Corticosteroid is commonly used as an immunomodulatory agent to modulate inflammatory cytokines to achieve immune homeostasis [48]. Steroid with high dosage was used to treat patients with SARS [49].

Ribavirin can suppress the replication of RNA virus. It has been used in treating hepatitis C virus, lassa fever virus and severe respiratory syncytial virus infection [50]. However, the usage of ribavirin did not reduce the intra-tracheal intubation or mortality rates [51]. It has significant toxicity which may cause hemolytic anemia and electrolyte disturbances [50].

Protease inhibitor for treating human immunodeficiency virus (HIV) infection has also been considered as a treatment for SARS. Lopinavir-ritonavir coformulation (Kaletra) blocks the virus

replicase polyprotein and prevents the replication of RNA. This is able to reduce the intubation and mortality rates especially administered in the early stage with ribavirin and corticosteroid [52]. Glycyrrhizin that can inhibit viral absorption and penetration has been found to be effective against SARS-CoV during and after the viral adsorption period [53]. The Interferons are partly effective against coronaviruses but the efficacy is not accurately tested [54]. Gamma immunoglobulins are used in SARS but the effectiveness remains to be evaluated [55].

Broad spectrum antibiotics such as fluoroquinolone or beta-lactams and macrolide are also utilized to treat nonspecific features and assisted ventilation is commonly used for respiratory failure in SARS patients [55].

## **COVID-19**

Broad spectrum antiviral drugs have been used in treating COVID-19 infection e.g oseltamivir, lopinavir, ritonavir and ganciclovir regimen; remdesivir and chloroquine regimen [40]. The invention of a specific antiviral drug for COVID-19 is still progressing. Potential compounds are available for further investigation such as EIDD-2801 (isopropyl ester of N4-hydroxycytidine), Sofosbuvir, IDX-184, Ribavirin and Remdisvir may be considered as its high therapeutic potential in treating emerged viral infection [56-57]. Meanwhile, there are not only the antiviral drugs needed for an infected patient but also the prophylaxis e.g. vaccine is required for the uninfected person especially for the healthcare workers. Antibiotics and ventilation support are also utilized in COVID19 patients [43].

## **Sequela**

## **SARS**

The exercise capacity and health status of SARS recoverees were significantly lower than the general population. In the early rehabilitation phase, the short and weak breath caused limitations in physical function because of reduced lung function with patchy changes. A minority of survivors had a mild decrease in carbon monoxide diffusing capacity [58]. Steroid resulted in some psycho-behavioral problems such as anxiety and depression, it might be improved gradually in most of the patients [59]. However, high dose corticosteroid treatment induced avascular necrosis of the joint and hip which further decreases the health status and mobility [60].

### **COVID-19**

Some patients recovered have 20-30% decrease of the lung capacity because of the reveal irreversible fibrosis [61]. This causes lung tissue scarring and stiffening as well as the immune system damage. Lung permanent damage may be leading to severe respiratory issues such as acute respiratory distress syndrome (ARDS) [62]. Younger patients have a better chance of recovery but patients within 40 to 50 years old only have little chance and difficulty back to their pre-illness status.

### **Preventions**

To prevent the spread of SARS and COVID-19, measures are based on effective infection control and isolation. The relative measures are mainly focused on 4 aspects, confirmed cases, close contact handling, community prevention as well as protection on healthcare workers.

### **SARS**

(i)Confirmed cases

On 12<sup>th</sup> of March 2003, the Department of Health in Hong Kong alerted World Health Organization (WHO) for the first notable suspected infection condition in Prince of Wales Hospital (PWH) ward 8A for handling the confirmed cases. The department of Food and Health Secretary started daily press briefings on the latest SARS condition and government measures for informing the public and increasing the effectiveness of tracing close contact person since 16<sup>th</sup> of March 2003. In the mid of April 2003, a temperature check was required for a person who arriving in Hong Kong to detect any suspected case of SARS [63].

(ii)Close contacted handling

On 31<sup>st</sup> of March 2003, all close contactors of SARS were mandated to report daily and designated medical centers by Department of Health for close contacted handling. Home quarantine measure extend to close contactors of a suspected case to minimize the opportunities of transmission for the virus since 25<sup>th</sup> of April 2003. Due to the increasing report of a confirmed case in block E Amoy Garden, isolation camp was opened for the evacuation of block E Amoy Gardens residents in April 2003 [64].

(iii)Community prevention

On 27<sup>th</sup> of March 2003, Hong Kong government announced the suspension of classes in all schools from 29<sup>th</sup> of March to 6<sup>th</sup> of April 2003 to prevent clustering. While there was no visiting policy extending to all acute ward in HA hospital for preventing further close contact cases. On 2<sup>nd</sup> of April 2003, the World Health Organization (WHO) issued a travel advisory recommended to postpone for all non-essential travel to Hong Kong and Guangdong. Education for the use of face mask, hand hygiene, disinfection of surfaces for fomites, avoiding contact with SARS

patients and their body fluids, covering your mouth by tissue when coughing or sneezing and other simple hygiene measures were provided by the government to prevent further community outbreak [65].

(iv) Protection on healthcare workers

Healthcare workers were advised to use personal protective equipment (PPE) including N95 masks for an aerosol generated procedure, face shield or goggles, gloves and isolation gowns with strict infection control to prevent the droplet and contact transmission. During the SARS period, health workers worked in a pair for mutually monitoring the infection control implement, especially wearing and removing the PPE. When transferring the confirmed patient, advise the patient putting on the mask to prevent the spread of droplets with viruses. Daily self-monitoring of fever and any other symptoms of SARS were implemented in Hospital Authority for early detection of SARS infection. The high-risk areas such as A&E, ICU and Isolation ward were adequately ventilated with negative pressure to prevent infection of the health workers [66].

## **COVID 19**

(i) Confirmed cases

On 8<sup>th</sup> of January 2020, Centre for Health Protection added “Severe respiratory disease associated with a new infectious agent” as the notifiable diseases in Hong Kong which gained the authority on quarantine for handling the confirmed case. All confirmed cases should stay in the hospital for isolation and treatment until fully recovered. Suspected cases were also required to isolate in the hospital until a negative result of SARS-CoV-2 observed. To increase the effectiveness of detecting high risk cases on admission to the hospital in early February 2020, the

patient's travel history was connected from the immigration department and shown in the hospital authority computer system (Clinical Management System). Temperature check maintained the routine check for person arriving in Hong Kong. The Health declaration form should be submitted compulsorily by paper or electronic for all travellers who arrived at Hong Kong International Airport from 8<sup>th</sup> of March 2020. Private doctors were allowed to collect a respiratory specimen for the symptomatic patient to send for viral testing at accredited private laboratories on 9<sup>th</sup> of March 2020 [67]. Started from 20<sup>th</sup> March, 2020, the Hospital Authority (HA) established 2 temporary COVID-19 virus test centers at the AsiaWorld-Expo and the North Lantau Hospital for people arriving in Hong Kong with upper respiratory symptoms to undergo viral test and to wait for the laboratory results [68].

(ii) Close contacted handling

All visitors arrived at Hong Kong who has been to Hubei Province in the past 14 days must be transferred to 3 quarantine centers (Chai Wan Lei Yue Mun Park and Holiday Village, Jao Tsung-I Academy Heritage Lodge, Chun Yeung Estate) [69]. On 19<sup>th</sup> of March 2020, all people arriving in Hong Kong who have been to Iran, Daegu and Gyeongsangbuk-do in Korea, Emilia-Romagna, Lombardy and Veneto regions in Italy within the past 14 days have to stay in a quarantine center for quarantine [70]. Compulsory home or accommodation quarantine for 14 days implemented to people who arrived in Hong Kong from Mainland China (but not include Hubei Province) on 8<sup>th</sup> February 2020 has been extended to people who arrived to Hong Kong from all any other overseas countries and area except Macau, Hong Kong and Taiwan since 19<sup>th</sup> of March 2020 [69]. Home or accommodation quarantine for 14 days, daily body temperature,

sign and symptoms monitoring are required and electronic wristbands are also worn to monitor the location of who have been isolated [71].

(iii)Community prevention

In the late of January government gradually declared to close all kindergarten, primary schools, secondary schools and special schools for community prevention; all amusement parks in Hong Kong including Hong Kong Disneyland Resort, Ocean Park Hong Kong and Madame Tussauds Hong Kong; all facilities of the Leisure and Cultural Services Department (LCSD) including public museums, public libraries, sports centers and venue were also closed to prevent clustering. Home office for working was advised. Special arrangements for the Hong Kong Diploma of Secondary Education examination, such as widen seating plan, compulsory use of mask and temperature measuring will be implemented to prevent cross infection. On 17<sup>th</sup> of January 2020, Hong Kong Government prohibited the entry of non-Hong Kong residents who have visited the Hubei Province in the past 14 days since 27<sup>th</sup> of January 2020 [71]. The High-Speed Rail train services have been suspended from 29<sup>th</sup> of January 2020 and the cross border train station has been suspended from 4<sup>th</sup> of February 2020 to prevent close contacted high-risk cases to Hong Kong. On 17<sup>th</sup> of March 2020, the Hong Kong Security Bureau extended the red outbound travel alert to all overseas countries/territories based on public health concerns [72]. Hospital Authority (HA) raised the emergency response level to emergency with no visiting, exceptions will be made for clinical consideration and suspended volunteer services or clinical attachment in all public hospitals to prevent further close contact cases on 25<sup>th</sup> of January [73-74].

(iv)Protection on healthcare workers

Every person in a public hospital was required to wear a surgical mask for preventing cross contamination with the emergency response level. Same to SARS conditions, the hospital authority advised using personal protective equipment (PPE) as discussed above. A special allowance as housing allowance (HK\$500/day) was provided for the healthcare staff working in high-risk areas for the purpose of renting accommodation for self-isolation to prevent close contact with their family so as to prevent from spreading to the community [75].

## **Conclusion**

The causes, transmissions, symptoms and preventive measures of SARS and COVID-19 are reviewed above. However, diagnosis and treatments remain for further study. Polymerase chain reaction for confirming the interaction of SARS or COVID-19 sometimes may show a false negative. There is no specific treatment regimen, only has a broad spectrum of antiviral drugs for COVID-19 patients and no vaccine for prevention at present. Nowadays, personal hygiene and protection are the most important for preventing the spread of COVID-19 such as wearing a mask and washing hands as well as reducing social contact including avoiding crowds, working in home, so on.

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All authors declare no competing interests exist.

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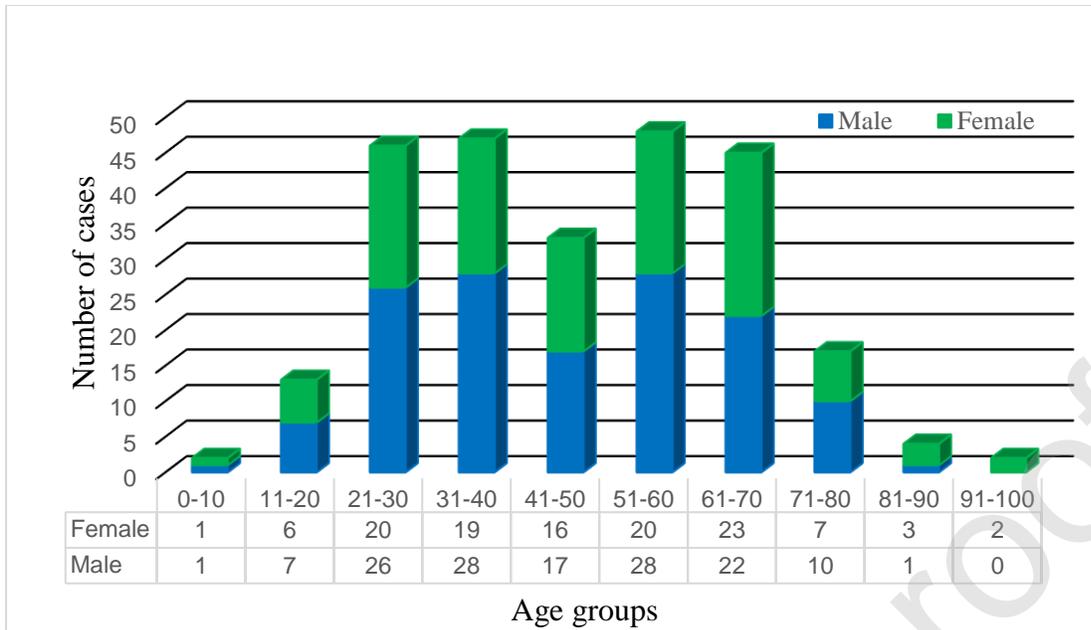


Figure 1. Infected cases in different age groups.

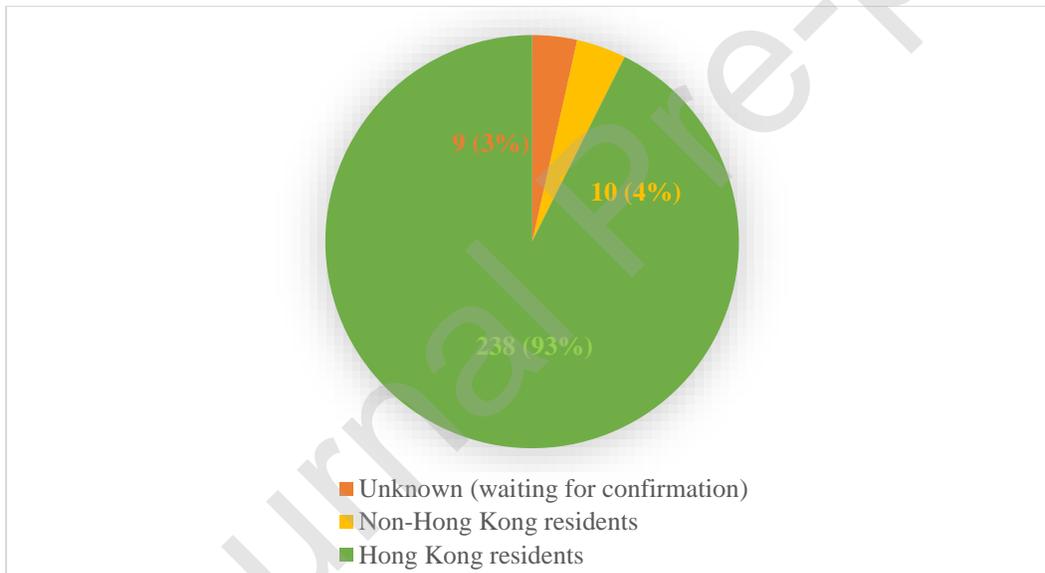


Figure 2. Identity for the confirmed cases.

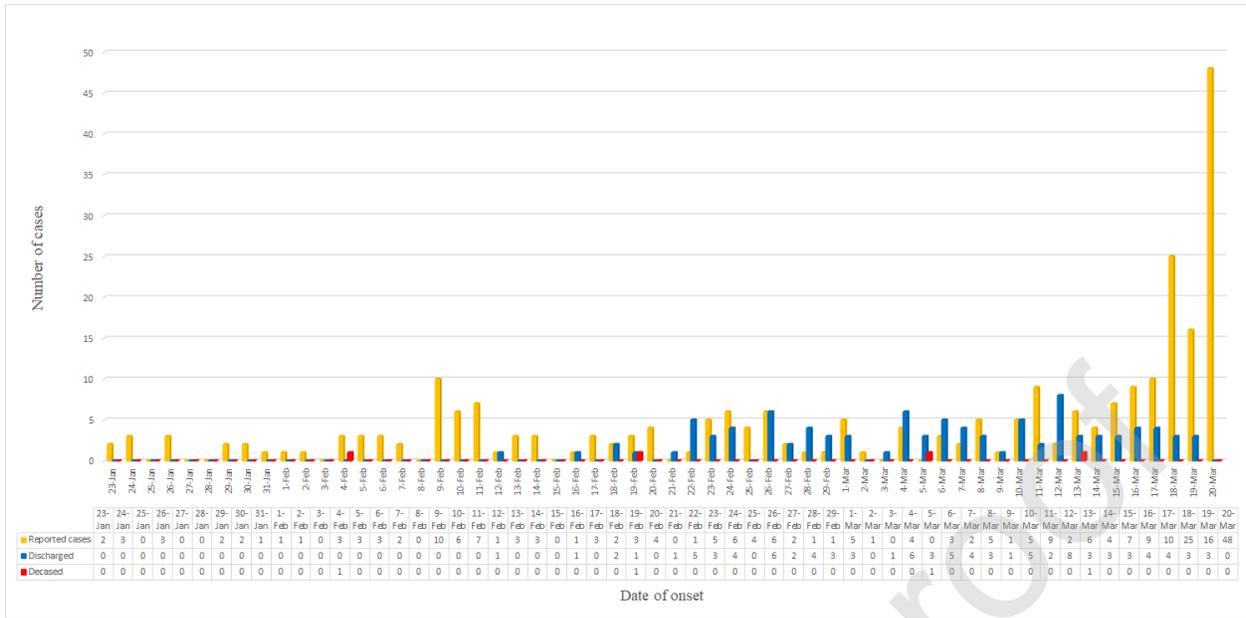


Figure 3. Infection number of Reported, Discharged and Deceased persons.

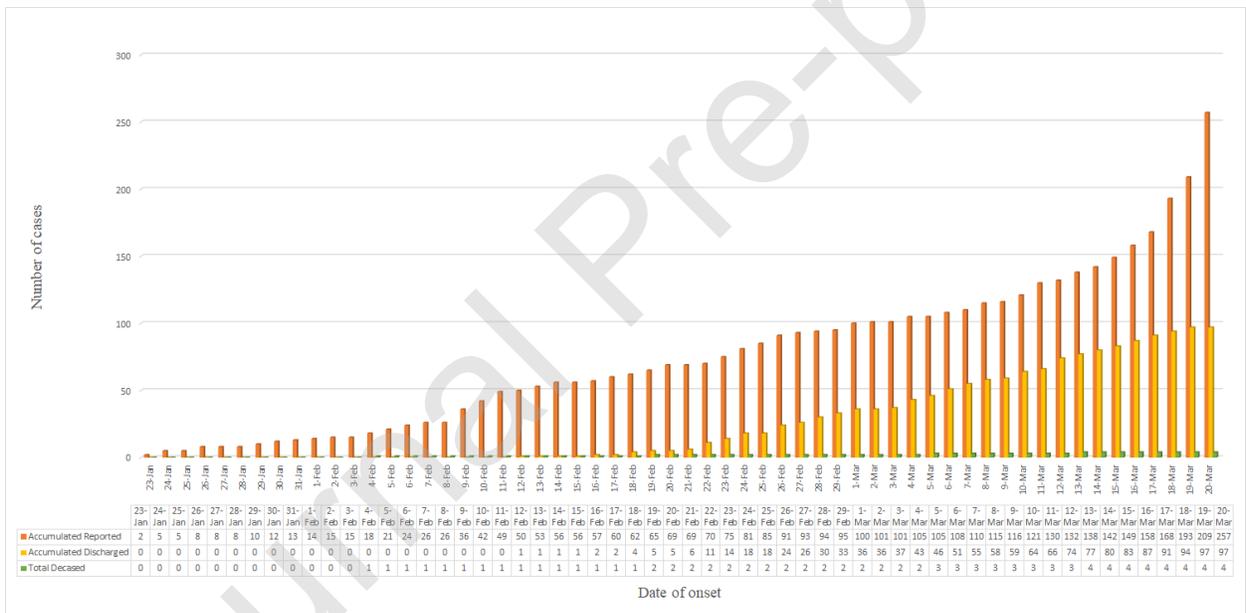


Figure 4. Infection of Accumulated Reported, Accumulated Discharged and Total Deceased persons.

Table 1. Systematic and respiratory disorders for SARS-CoV-2 and COVID-19.

	<b>SARS</b>	<b>COVID-19</b>
Systematic disorders	High fever, >38.0°C Headache Cough (Dry) Fatigue Diarrhea (10-20% of patients)	Fever Headache Cough Fatigue Diarrhea (2% of patients) Sputum production Haemoptysis Dyspnoea Lymphopenia
Respiratory disorders	Rhinorrhea Sneezing Sore throat Pneumonia Mild respiratory problems	Rhinorrhea Sneezing Sore throat Bilateral pneumonia Ground-glass opacity Acute respiratory distress symptoms