

SEVERE ACUTE RESPIRATORY SYNDROME CORONAVIRUS-2 (SARS-COV-2) INFECTION: AN EPIDEMIOLOGICAL REVIEW

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ABSTRACT

Background: New strains of different organisms, three of which has been caused by betacoronavirus (SARS-CoV, MERS-CoV and SARS-CoV-2) have caused epidemics and pandemics. The COVID-19, caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) started in China in December 2019 has spread globally. Understanding its pattern of spread and how it affects the populace helps to guide formulation of strategies at curbing its spread, managing the disease and allocation of limited resources in tackling the pandemic.

Methodology: This is a review article about the epidemiology of the coronavirus disease -2019 (COVID-19). Various search engines were used to accumulate literature on the topic; these include PubMed, Google scholar, Ajol.

Result: As at October 29, 2020, SARSCoV2 has spread to all continents except the Antarctica. Though a zoonotic disease, human to human transmission has resulted to this pandemic is via direct and indirect contact of droplets with mucosal surfaces. Most severe cases occur among the elderly, males, and people with co-morbid diseases. The average incubation period is 2-10 days. When compared with SARS-CoV (Ro: 2.3-3.7, mortality rate 11%) and MERS-CoV (Ro: 0.8-1.3, mortality rate: 34.3%), SARS-Cov-2 is a highly infective (Ro: as high as 6.5) with low mortality rates (average range mortality rates 1.83-6.3%).

Conclusion: COVID-19 is a highly infective novel virus. Older persons and people with medical comorbidities are more susceptible to the severe form of the disease and mortality. As the second wave comes on, a sustainable measure of limiting the spread and consequences of COVID-19 should be more emphasized.

Keywords: Coronavirus, Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), COVID-19, Epidemiology, pandemic.

INTRODUCTION

An epidemic is a sudden outbreak of an infectious disease in a particular geographical location¹ while a pandemic is described as an epidemic occurring worldwide crossing international boundaries and usually affecting a large number of people.² An influenza pandemic occurs when a new influenza virus emerges and spreads around the world.³ The outbreak of diseases depends on several factors some of which are, the type and infectivity of organism, mode of transmission of the disease, presence of population immunity, and number people exposed to it.³

Brief History of Common Epidemics/Pandemics

All pandemics that have occurred were caused by new strains of viruses⁴, most being zoonotic diseases passed

on from animals to man.⁵ Due to their highly contagious nature, the infection spreads rapidly and widely among human population within a very short period.⁶ Several pandemics have occurred over the years with the latest being the SARS-CoV-2.

The Spanish flu, tagged as the worst pandemic ever, produced a devastating disease between 1918-1919, occurred in three waves and killed 20-40 million people globally.^{7,8}

The swine flu also known as the pig flu is caused by the swine influenza virus was first isolated in a pig for the first time in 1930 and has been the cause of sporadic outbreaks in pigs and humans.⁷ The first case

of human swine flu pandemic occurred in 2009 affecting 135 countries with 94,512 cases and 429 deaths.⁹

The Zika virus caused an epidemic in Brazil between 2015-2016 with 1,500,000 cases.^{10,11} The virus was named after the Zika forest where it was first isolated in Uganda in 1947, it is transmitted through a bite from an infected *Aedes* mosquito species.¹¹

The Ebola virus causing Ebola viral hemorrhagic disease derives its name from the Ebola River in the Democratic Republic of Congo, where it was first isolated. It is transmitted to man by eating an infected fruit bat and has caused several sporadic epidemics over the years and has a mortality rate of 90%. The first outbreak of the disease occurred in 1976 in South Sudan and Zaire (now Democratic Republic of the Congo)¹² and the latest occurred between 2014 and 2016.¹³

By 2020, three of the epidemics/pandemics so far experienced have been caused by the novel strains of the beta coronaviruses with influenza-like symptoms, the Severe Acute Respiratory Syndrome coronavirus (SARS-CoV), the Middle East Respiratory Syndrome (MERS) and the Severe Acute Respiratory Syndrome coronavirus -2 (SARS CoV-2).¹⁴

SARS CoV caused an outbreak in China in 2002 with pneumonia-like symptoms¹⁵ with 29 countries affected. From 2002 to 2003, there were 8,422 cases and 916 deaths and a mortality rate of 11%.¹⁶

MERS-CoV infected man through direct and indirect contact with dromedary camels and camel products started an outbreak in the Kingdom of Saudi Arabia 2012.¹⁷⁻¹⁹ By 2019, it has spread to 5 continents involving 27 countries with 2,499 confirmed cases and 858 deaths and a mortality of 34.5%.²⁰

Emergence of Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2)

The outbreak of COVID-19 originated from Wuhan City, Hubei Province, China in December 2019, when a cluster of patients with pneumonia of unknown cause were managed. It was traced to a seafood market at Wuhan. A novel virus, identified as a type of coronavirus was isolated as the causative organism on January 7, 2020 by Chinese scientists.²¹ The interim name 'novel coronavirus 2019' (2019nCoV) was proposed for the virus by the World Health Organization (WHO)²² and the definitive name was announced as "severe acute respiratory syndrome coronavirus-2" (SARS-CoV-2) by the International Committee on Taxonomy of Viruses (ICTV) in March

2020.²³ The pneumonia resulting from this viral infection has been named COVID-19 (coronavirus disease 2019) by WHO in February 11 2020.²⁴ The WHO also declared it as a Public Health Emergency of International Concern (PHEIC) on January 30, 2020, and as a pandemic in March, 2020 as it spread round the world.²²

Incidence of COVID-19

COVID-19 has affected 216 countries and territories globally and 2 international conveyances²⁵. According to WHO, as at 29th October 2020, COVID-19 has caused a total of 44,002,003 confirmed cases and 1,167,988 deaths (2.65% case fatality rate) reported worldwide.²⁶ The Americas (45.5%), Europe (22.5%) and South-East Asia (20.6%) being the continents hardest hit by the pandemic with the United States (19.7%), India (18.3%) and Brazil (12.4%) being the countries most affected with the viral infection and the Antarctica have no reported case.²⁶ The United States (19.3%), Brazil (13.5%) and India (10.3%) have the highest number of mortalities from the disease.²⁶

Africa was the last continent to be affected by the Coronavirus, and only accounts for 3% of infections worldwide²⁶. The first confirmed cases in Africa was in Egypt on 14th of February, 2020, and did not become wide spread in Africa till mid-March, 2020. Although challenges with knowing the true burden of COVID-19 in the African continent exists due to the inadequate testing capacity for COVID-19²⁷ review of available studies have noted that COVID-19 concentration in urban areas, among lower socioeconomic status communities, and within congregate living settings.²⁸ America, Europe and east Mediterranean continents appear to be experiencing a second wave of the infection.²⁶

Incidence of COVID-19 by Gender

Available information on the susceptibility to SARS-CoV-2 infection based on gender is varied across continents; most studies however, show no significant difference in the likelihood of acquiring the infection based on gender. Majority of studies and reviews from China, Japan and studies from Africa showed relatively equal gender distribution or mild male/female preponderance amongst patients infected with coronavirus with the male to female ratio of 0.92–1.4:1.²⁹⁻⁴⁰ However, isolated studies from China, Africa and available data from Iran noted males were almost three times likely to be infected with SARS-COV 2 with M: F ratio of 1.93-3.25:1.⁴¹⁻⁴⁴ Quite contradictory however, were studies from Korea, Europe and a study from Zhejiang province in China where females were noted to be almost twice likely to be infected with coronavirus with M: F ratio of 0.48 – 0.7:1.⁴⁵⁻⁴⁷

While these variations might be coincidental, they could as well be a result of factors which are not yet known. Could these observed variations be due to the likelihood of involvement with outdoor activities, likelihood to seek health care based on cultural norms as most of these studies are hospital based studies, or is it related to the likelihood of being charged with taking care of ailing family members or neighbours, or could there be some hormonal factors that affect the expression of the receptors for the virus on the mucosal surfaces. These are definitely areas for more research.

Age and COVID-19

All ages are at risk of contracting SARS-CoV-2. However, studies on the epidemiology of COVID-19 are unanimous in finding the middle age group as the predominant age group affected by the viral infection while children and the elderly above 80 years being the age groups which are least likely to harbor the infection. Several studies across all continents have noted that most patients diagnosed with COVID-19 are aged 30-79 years constituting 74.3% - 91.2% of confirmed cases.⁴⁶⁻⁵⁴ Other studies further confirm that the middle aged groups are the most affected by the coronavirus pandemic^{33-36,48} with a mean age range of 38.76 - 56.7 years^{46,49} and median age range of 41.5 - 59 years.^{38,48}

COVID-19 in children has been noted to run a milder course than in adults as they are more likely to have asymptomatic, mild or moderate disease, constituting 94.1-100% of COVID-19 cases in children.⁵⁰⁻⁵³ Children are less likely to have severe disease as they constitute 0-5.9% of severe or critical cases.^{50,51} However, amongst children, infants have been noted to be more likely to have severe disease. Dong et al found that infants constituted 32% of severe and critical cases among COVID-19 cases in children studied in China.⁵¹

Health Workers and COVID-19

Nosocomial transmission to health workers have being a worry as it will affect the number of available frontline health workers in hospitals to care for patients during this pandemic that is constantly overwhelming medical facilities. In China, health care workers constituted 2.4% - 4.6% of COVID-19 cases.^{49,54} Infection rates were higher in Europe, in a review of COVID 19 cases across Europe, 30.7 % of infected patients in the study were healthcare workers.⁴⁶ Also, health workers constituted 9.2% of COVID-19 infections in Italy⁵²

Asymptomatic, Mild, Moderate, Severe And Critical Infection

COVID-19 is a self-limiting viral infection and it runs a mild course in most patients.⁵⁵ Review of studies have demonstrated that more than 80% of patients are asymptomatic or run a mild or moderate disease (81-91% of all cases) with severe and critical disease noted in 7.7 -9.1% of COVID-19 patients. Other studies have found higher rates of severe disease ranging 17.6-22.1% of patients.^{56,57}

Severe COVID-19 Disease

With any disease, factors associated with severe disease and mortality are of importance, as they form a key concern and as such efforts are concentrated in preventing these outcomes or deciphering effective early intervention to prevent mortality. Such is a key concern with COVID-19. Elderly people, male gender, people with co-morbidities (underlying diseases), and those with compromised immune status have been noted to be more likely to have severe disease. Studies have shown that patients aged 60 years and above, particularly patients above 80years and those with underlying medical comorbidities are more likely to be develop severe disease of COVID-19.⁵⁷⁻⁶⁰ Pan *et al.* in a review of epidemiology of COVID cases in Wuhan noted that 41.3% of severe cases occurred among the elderly.²⁹ Allergic diseases, asthma, and chronic obstructive pulmonary disease (COPD), were also identified as predisposing factors for severe COVID-19 disease.⁶¹ Pregnant women and neonates have also been noted to be more likely to develop severe cases of COVID 19,⁵⁹ this is perhaps due to their impaired immune status. Furthermore, the male sex has been found to be more likely to develop severe forms of COVID-19.³⁴⁻³⁶ Lechen *et al.* observed that females and young COVID-19 patients more frequently had mild symptoms⁴⁶ and Pan *et al.* in review of COVID 19 in Wuhan found that more male patients had severe disease compared to female patients.²⁹

Fatality/Mortality Rate

Although the overall mortality rate for COVID-19 is low, it has been noted to correlate with the epidemiological dynamics of severe cases, being higher among the elderly, patients with underlying medical conditions and males. In a review of COVID-19 patients male gender, older age, and having underlying diseases were significantly associated with higher mortality.^{41,44}

The case fatality rate in China has ranged between 1.83% - 4.05%,^{54,56} though Sun *et al.* reports mortality rates as high as 15% from some studies.⁴² Outside China, lower mortality rates have been reported 0.25%

to 2.6%.⁶¹⁻⁶⁴ However, in a review by Bulut *et al.*, higher values were found⁴⁸. The mean case fatality rate across several countries in Asia, Europe and South America was 6.3% (0.81-15.23%) with the highest fatality rates noted in countries with more elderly patients.⁵⁷ Similar age related mortality was also noticed by Wu *et al.*, who found mortality to be closely related with increasing age with a case fatality rate of 14.8% in patients aged ≥ 80 years and 35.7% in patients underlying illness.⁴⁹ Mortality from COVID-19 in Europe from the most affected countries (France, Italy and Spain) (8.8-15%) was higher than that in observed in China^{59,65} with almost half of the deaths occurring in those older than 80years.⁶⁶

Mortality rates in Africa have been observed to be relatively low compared to the rest of the world. with mortality rates majorly less than 5%^{44,67} though rates as high as 9-15% have been recorded in few countries.^{27,43} This low mortality rate has been ascribed to several reasons such as effective mitigation measures, population that is more youthful, favorable weather, and possible prior exposure to a cross-reactive virus with Njenga *et al* noting a youthful population and the favorable weather as the most compelling arguments⁶⁸ When compared with similar pandemics caused by viruses in the same family (SARS-CoV and MERS-CoV), SARS-CoV-2 has a lower mortality rate compared to SARS-CoV (11%)¹⁶ and MERS-CoV (34.5%).²⁰

Transmission and Mode of Spread of SARS-Cov-2

About 66% patients initially diagnosed with the pneumonia in China had been in contact with the seafood market in Wuhant.⁶⁹ The exact animal responsible for transmission of SARS-Cov-2 as well as the specific mechanism of infection/transmission route from animals to human remains unclear.⁶⁹ Several reports have suggested different animals such as snakes, birds, bats as reservoirs and intermediate hosts.⁶⁴ Bats are considered to be the most likely initial hosts of SARS-CoV-2, while pangolins may be the intermediate hosts.³⁴

Human to human transmission appears to be the most important route of spread for this pandemic. Evidence in support evolved when several cases of COVID-19 was detected among individuals who had not been to the Wuhan market, among family clusters and among health workers who were caring for COVID 19 patients, as well as clustered infections in work places and public transportation.^{70,71} Human to human transmission occurs through direct or indirect contact with droplets or fomites containing particles of the virus^{57,65} produced by coughing or sneezing from infected individuals^{64,72} came in contact with mucous

membranes of the eyes, mouth or nose.^{59,73} Aerosol transmission within the general population has been speculated but review of available evidence remains inconclusive.^{56,57} However within hospital settings, aerosol generating procedures such as nebulization, suctioning, intubation, bronchoscopy and cardio-pulmonary resuscitation for COVID-19 patients could lead to spread of the infection.⁶⁵ Scientists have discovered that SARS-CoV-2 binds to the ACE2 receptor, which is ubiquitous on human mucosal cells, thus exposed mucosa surfaces like that of nose, eye and mouth have been suggested as the most likely routes of entry of the virus into the human body.³⁰

Faeco-oral transmission has also been speculated due to identification of the virus in feces and gastrointestinal secretions,^{70,73} however, the validity of such theories are yet to be ascertained.^{56,57} SARS-CoV-2 have also been detected in body fluids/secretions, urine, and tears of infected individuals,^{65,70} though no clear evidence that they can be a source of transmission of infection. There is also no evidence of vertical transmission of SARS-CoV-2 from mother to child.^{64,73}

Human to human transmission has been found to occur not only from symptomatic patients but also from asymptomatic individuals^{58,72} who may not be even aware that they harbor the viral infection. Study of COVID-19 patients revealed that there is no difference in the viral load of asymptomatic and symptomatic patients; suggesting risk of transmission from asymptomatic individuals.³⁰ Du *et al* also noted that 13% of patients in their study were contagious before being symptomatic.⁷⁴

Healthcare workers exposed to COVID-19 patients and family members of COVID-19 patients appears to have the highest risk of contracting the disease due to their increased contact with the patients.³⁴

Reproductive Rates and Incubation Period

Several studies on the incubation period and the reproductive rate of the SARS-CoV-2 virus are aimed at determining the period of isolation of infected individuals and quarantine of contacts, determine the infectivity of the virus and monitor the rate of spread of the disease. The basic reproduction number (Ro), is the average number of secondary cases generated by an infectious case. As long as the Ro is more than 1, human-to human transmission would persist. The aim at flattening the curve of transmission is for Ro to be less than 1.

Reproductive Rates

Ro estimates from several studies were 1.4 to 6.49.^{61,75} In a review of 21 estimates for the Ro, it ranged from

1.9 to 6.5, but majority (62%) of estimates were between 2.0 and 3.0.⁶² The average Ro from reviews worldwide (2- 6.47)⁷⁶⁻⁷⁸ is comparable to data from China (1.4 to 5.7),^{57,61} South Africa (2.95),⁷⁹ Italy (2.5 – 3.6),^{66,80} other European countries (3.1 to 6.56).⁵⁷ Cold and dry conditions have been noted as potentiating factors for the spread of the virus.⁸¹

SARS-CoV-2 has a significantly higher infectivity rate compared to other epidemic/pandemic causing viruses in the same family (SARS-CoV (Ro: 2.3–3.7) and MERS-CoV (Ro: 0.8–1.3) that have caused epidemics in humans.^{33,78}

Incubation Period

Global review of estimates the incubation period of SARS-CoV-2 varied, but most studies reveal values which ranged between 2 -10 days with average incubation periods of 5-7days.^{77,82} Several studies further documented 14 days as the upper limit of the incubation period.^{71,72} However longer incubation periods, 19-27 days, have been reported.⁸⁴⁻⁸⁶

Prevention of SARS-CoV-2

Ro estimates in China were found to reduce to below 1 with rapid diagnosis and isolation of infected patients.⁶¹ Similar findings were noted by Zindonga *et al.* with 80.31% reduction in infection rate of COVID-19 after institution of lockdown in South Africa.⁷⁹

The use of facemask, hand hygiene, social distancing, isolation of infected patients have been associated with decrease in spread of the coronavirus.^{87,88} The most consistently effective measure in reducing risk of SARS-CoV-2 infection being the use of face masks risk.⁸⁹ Derek *et al.* in a systematic review noted that the transmission of viruses was lower with use of facemasks, eye protections and maintaining physical distancing of 1 m or more.⁹⁰

Amongst health workers, there is clear association between the use of personal protective equipment (PPE) (facemasks, gloves, gowns, eye protection, shoe covers) and decreased risk for nosocomial transmission of SARS-CoV-2 infections. Infection control training and education also helped reduce transmission. Inadequacy of PPE supplies is associated with increased risk for infections for health care workers.⁸⁹

CONCLUSION

COVID-19 is a highly infective novel virus with varying incidence in different countries and has low mortality. Older persons, males and people with medical comorbidities are more susceptible to the severe form of the disease and mortality from the disease. Use of

facemasks and eye shields, regular hand hygiene and maintaining social distance of at least 1 metre are effective measures in limiting the spread of SARS-CoV-2? As the second wave comes on, should lockdown be considered as a sustainable measure of limiting the spread of COVID-19 or should more emphasis be laid on enforcing preventive measures and putting in place modalities for early identification and treatment for the population with highest risk of severe disease and mortality from SARS-CoV-2. Given the highly infective nature of this viral infection and the absence of vaccine, maintaining a flattened curve may be a challenge, perhaps impossible. Reducing the transmission with preventive measures compatible with daily activities and reducing mortality from the disease is more feasible and practical and efforts should be moulded in that direction.

Conflicts of Interest

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