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Review Article

One health perspectives of SARS-CoV-2 (COVID-19) outbreak

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ABSTRACT

Coronaviruses can produce a mild disease equivalent to the common cold, or a more serious illness, such as Middle East Respiratory Syndrome (MERS) or severe acute respiratory syndrome (SARS). The severity of the illness is determined by the host's immune system. Coronaviruses are a kind of pandemic virus that may infect people and a wide variety of other species. These viruses are responsible for a variety of illnesses that affect the bronchial, intestinal, hepatic, and neurological systems. The fact that animals may act as reservoirs for SARS-CoV-2, the virus that causes COVID-19, has significant repercussions not only for human health but also for the welfare of animals and the general population. This study investigates the spread of the SARS-CoV-2 virus from people to animals, provides evidence of infection in domestic and captive animals, analyzes the consequences for animal welfare and health, and investigates preventative methods and monitoring tactics in animal populations. To prevent the further spread of the virus and preserve both human and animal populations, it is essential to understand the potential for animal reservoirs.

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Introduction

The coronaviruses, sometimes known by their abbreviation CoV, are a family of viruses that can infect humans and other animals (Liya et al. 2020). They belong to the family known as the Coronaviridae family (Zmasek et al. 2022). Coronaviruses (CoV) are a family of viruses that may infect both animals and humans. They are a part of the family known as Coronaviridae. Coronaviruses have the potential to cause a minor sickness, comparable to the common cold, or a more severe illness (such as MERS or SARS, which stand for Middle East Respiratory Syndrome and Severe Acute Respiratory Syndrome, respectively). Because of its worldwide dissemination it has affected around 21 million individuals and resulted in 0.75 fatalities overall. Furthermore, it has limited the mobility of most of the population over the last several months. COVID-19 has emerged as a leading force in addressing some of the most pressing environmental, economic, and social issues of the 21st century. There have been several reported incidences of SARS-CoV-2 infectious diseases in animal hosts such as dogs, cats, tigers, lions, and minks. As a direct consequence of this, pet owners are becoming

more concerned. In addition, there is a need for more research into the features of sickness, especially about the viral transmission from animals to humans and humans to animals. Indicators include symptoms related to the respiratory system such as fever, coughing, and abnormal breathing. In its most severe forms, an infection has the potential to induce pneumonia, acute respiratory syndrome (SARS), or even death.
To prevent COVID-19, we may follow the basic protocol which includes washing of hands properly with soap, covering of mouth properly especially when coughing and sneezing with a slightly bent elbow or a disposable tissue, and attempting to avoid direct contact with anyone who has a cold or a sniffle (Disemadi and Handika 2020). At the end of 2019, the COVID-19 (coronavirus infection) case was documented for the first time. The World Health Organization (WHO) said there was a global outbreak of the sickness in March 2020 after the virus had already spread to every continent in only a few weeks. Since its first discovery in Wuhan, China, the virus has spread over the whole continent (Khan et al. 2020a). According to reports, the virus has infected roughly 558,502 individuals across the globe since approximately March 01, 2020, with at least 25,251 people losing their lives. The incidence of CoV crossover is alarmingly high because transcription errors and jumps in RNA-dependent RNA polymerase (RdRP) are continually increasing in frequency (Randhawa et al. 2020).
Coronaviruses are a kind of pandemic virus that may infect people and a wide variety of other species (Dhama et al. 2020). These viruses are responsible for a variety of illnesses that affect the bronchial, intestinal, hepatic, and neurological systems. According to Yin and Wunderink (2018), viruses may cause symptoms that vary from moderate to severe enough to warrant treatment in an intensive care unit (ICU). This specific virus family is rather extensive, and members of it may be discovered in a wide range of wild animals, most notably camels, cattle, cats, and bats. During the early stages of severe illnesses brought on by CoVs, palm kittens and dromedary camels have been hypothesized to act as biological reservoirs of the coronaviruses (CoVs) responsible for SARS and MERS, respectively (Yin and Wunderink 2018). On the other hand advancements in antiviral treatment and genomic research have shown that bats act as a reservoir host for both MERS-CoV and SARS-CoV and the both viruses need an intermediate host before causing human infection (Yin and Wunderink 2018). This recently discovered infectious illness produces a severe lung infection, which usually presents itself as a mild respiratory system infection or bronchitis.

Coronavirus (COVID-19) pandemic

Coronavirus belongs to the family of Coronaviridae, which causes infection in both humans and animals (Hassan et al. 2020). Coronavirus-causing infection in humans is usually mild, while others cause more severe diseases includes MERS and SARS (Decaro and Lorusso 2020). The prevalence of COVID-19 is very drastic, affecting 21 million people globally including 0.75 million deaths worldwide. This restricts the movement worldwide (Azzouzi et al. 2022). The most significant economic, medical, and humanitarian problem of the twenty-first century is COVID-19. Increasing the concern of pet owners because several cases are reported in animals of SARS-CoV-2 (Braverman 2022). SARS-CoV-2 is reported in cats, dogs, tigers, minks, and ions. Moreover, further explanation of this disease is still required regarding the transmission cycle of this virus from animal to human and human to animal (Mahdy et al. 2020). Respiratory problems are the major concern, including dyspnea, cough, and fever (Clayton et al. 2022). Pneumonia and acute respiratory syndrome are more common in severe instances and sometimes death also occurs (Pal et al. 2020). The first case of Coronavirus was reported in 2019 in Wuhan, China. In March 2020, it was declared a pandemic by WHO because of its rapid prevalence throughout the world (Riccardo et al. 2020). The virus that first manifested in Wuhan, China has traveled across continents. Coronavirus has high recombination rates because of the RNA-dependent RNA Polymerase (RdRP) jumps and the continually evolving transcription mistakes (Wells et al. 2023).

Modes of transmission

The family of coronaviruses is quite large, and is commonly present in different species of animals, which includes bats, cats, camels, and cattle (Grellet et al. 2022). Transmission from animals to humans is rare, but human-to-human transmission is very common, which is the main cause of endemics and pandemics like COVID-19, MERS, and SARS (Kayode et al. 2021). Palm cats have been suggested to be a natural reservoir of Human CoVs for SARS and dromedary camels for MERS during the beginning of significant epidemics induced by CoVs (Talwar 2023). More recent virological and genomic research, however, have revealed that bats are reservoir hosts of both SARS-CoV and MERS-CoV and that both viruses first employ the other relevant species as intermediary hosts before spreading to humans (Al-Salihi and Khalaf 2021). The primary method of transmission is thought to involve aerosol production in the air. Aerosols are particles with a diameter of less than 100 m (Tellier et al. 2019). As a result, the virus may be more easily contracted directly because of its tiny size and airborne suspension (Wang et al. 2021). Aerosols can develop during a variety of surgical and dental operations or when an infected patient is talking, coughing, or sneezing and form as droplet nuclei (Rabaan et al. 2022). Eight members of the medical staff and five postoperative patients who had contact with an infected patient during a study by Li et al. both tested positive for COVID-19 (Li et al. 2020). This implies that the production of droplets is a powerful method of human-to-human transfer (Li et al. 2020).

Transmission of the SARS-CoV-2 virus between humans and animals

Transmission from a SARS-CoV-2 ancestor to humans may have occurred during unnoticed transmission from one human to another. The genomic features could have been acquired through the above-discussed adaptation (Zhan et al. 2020). Pandemic of COVID-19 can blow out very fast among humans and can cause severe ailments (Gupta et al. 2021). The genomic characteristics that have been described above are present in all sequenced SARS-CoV-2 genomes indicating that they all originate from a shared ancestor that also possessed these features (Parlikar et al. 2020). Given the similarity between the presence of an RBD in pangolins and that of SARS-CoV-2, it is reasonable to infer that the virus that crossed the species barrier to infect humans also had this RBD (Sallard et al. 2020). During the transmission from *Homo sapiens* to *Homo sapiens*, the addition of a cleavage site, which is polybasic, occurs (Zhao et al. 2020).

It is estimated according to the most recent sequencing data, a common ancestor of SARS-CoV-2 was discovered, which resulted in the virus's emergence between November and December 2019, consistent with the immediate in retrospect cases confirmed (World Health 2021). The assumption made in this scenario is that there was a time when transmission was happening in humans without being noticed, which happened between the preliminary zoonotic incident and the attainment of the cleavage site (polybasic) (Chrysostomou et al. 2021). This is the case with MERS-CoV, where all human cases are caused because of repeated viral transitions originating from camels (El-Sayed and Kamel 2021).

Information on cryptic spread can be obtained through studying stored human samples. Some retrospective serological studies were conducted, which revealed that short-term exposure to SARS-CoV-like coronaviruses in particular parts of China (Nguyen and Chan 2022). Yet, it was uncertain if these exposures were caused by previous infections with SARS-CoV, SARS-CoV-2, or other similar coronaviruses (Sobsey 2022). Further serological investigations are necessary to determine how much prior exposure humans have had to SARS-CoV-2 (Letizia et al. 2021).

Coronavirus infections in companion animals

Coronaviruses that are carried by domestic animals that may cause gastrointestinal infections include those carried by felines, ferrets, canines, horses, and alpacas (Haake et al. 2020). There is a potential for fatal immuno-inflammatory systemic illness to be caused by ferret systemic coronavirus as well as it is a mutant feline enteric coronavirus called the feline infectious peritonitis virus (Haake et al. 2020). Recent viral outbreaks, including SARS, MERS, and COVID-19—all believed to be caused by coronaviruses from bats—highlight the zoonotic potential of coronaviruses and their potential for catastrophic consequences (Ye et al. 2020). A better understanding of coronaviruses, their ability to spread across species, and the exchange of genetic information could make it simpler to enhance preventative and control measures for coronaviruses that might break out as pandemics. The extremely productive family of viruses known as the Coronaviridae infects several classes and orders of vertebrates, including humans, and causes illnesses ranging from localized respiratory or gastrointestinal infections to systemic disease (Haake et al. 2020). In companion and agricultural animal species such as dogs, cats, ferrets, horses, alpacas, pigs, bovids, and poultry, and many wild animal species, coronaviruses significantly increase morbidity and death (Sreenivasan et al. 2021). The formation of FECV serotype II was caused by the cross-species transmission of canine enteric coronavirus to cats, which caused genetic recombination between FECV serotype I and CCoV serotype II (Terada et al. 2014). The formation of canine coronavirus variants with spike protein N-terminal domains that are most likely transmissible gastroenteritis virus (TGEV), a coronavirus of pigs, was also caused by recombination between serotype II CCoV and other coronaviruses (Decaro et al. 2009). Point mutations caused by viral polymerase errors, genetic recombination between various coronavirus strains and species, and the integration of genes from other viral taxa via nonhomologous recombination (Lai and Cavanagh 1997) illustrate the coronaviruses' genetic flexibility and add to their worrying capacity to "jump species" (Forni et al. 2017). Three human coronaviral pandemics (SARS, MERS, and most recently COVID-19) suspected to have originated from bat coronaviruses during the previous 20 years (Fan et al. 2019), illustrate coronaviruses' capacity for zoonotic transmission. Pathogens arise gradually, and their rates of worldwide dispersion are accelerated (Jones et al. 2008) representing a profound threat to global health and world economies. In alignment with the concept of "One Health," a more thorough understanding of the coronaviruses of companion animals, their biological properties, their ability to recombine and to acquire new biological attributes, and their capacity for cross-species transmission has the potential to improve prevention and control measures for future emerging zoonotic coronaviruses (Cui et al. 2019).

COVID-19's effects on livestock health and food production

Animal mobility limitations caused by pandemic lockdowns have damaged the animal feed supply chain. Consumption, supply, and production were significantly interrupted (Haake et al. 2020; Hobbs and Reid 2021). So, the animals used for agriculture started facing a lack of essential feed elements. The epidemic has caused dry feed shortages in more than Pakistani dairy farms (Khan et al. 2020b). International bans on animal feed exports and imports affected the availability of certain essential livestock-raising components (Hashmi et al. 2021). The basic materials include carbohydrates, proteins, lipids, minerals, and vitamins. The world's largest soybean exporter, Argentina, had to cut soybean shipments to feed mills by half. U.S. as well as Brazil also struggled to export soymeal and grain. Pastoralists in African arid terrain were incapable of providing proper feedstuff to their animals, which were given natural vegetation. Multinational and municipal regulations have raised animal feed prices, affecting animal farms in many nations. Bangladeshi dairy feed prices rose by 3.7%. The epidemic has raised livestock feed component costs by 15% in India and several African countries COVID-19 has raised UK costs for animal feed, which includes wheat, maize, soy meal, molasses, and some other products (Mason-D'Croz et al. 2020). Additionally, COVID-19 has had a detrimental influence on attempts to prevent the spread of zoonotic illnesses and other infections that have an impact on both human and animal health, such as disease monitoring programs, animal health extension services, and food safety inspections, all of which were crucial controls (Gortázar and de la Fuente 2020). Future pandemics and outbreaks might be made more likely as a result, endangering both human and cattle health (FAO 2020b). The pandemic's widespread market disruption affected the agricultural workforce, leading to staff shortages and animal production workers being laid off (Biswal et al. 2020). In the cattle sector and meat processing factories, migrant laborers make up a sizeable share of the workforce (Marchant-Forde and Boyle 2020). Because of the lockdowns, closures, and other precautions to be occurred during the epidemic, numerous individuals were forced to return to their home countries (Shirsath et al. 2020). Most of the country was shut down by China during the height of the epidemic, which left a labor shortage in the slaughterhouses (Pan et al. 2020).

Animal products affected by COVID-19

Because of the population increase in numerous countries, meat consumption has been rising globally. During the COVID-19 epidemic, employment in slaughterhouses and meat-packing industries was a substantial danger (Ijaz et al. 2021). A meat factory is infected with SARS-CoV-2 and also slaughterhouse workers in England, Germany, Portugal, and Wales are infected (Ijaz et al. 2021). After the Portugal incident, the chicken slaughterhouse was temporarily closed and rigorous sanitary measures were implemented, including employee health assessments, new washing spaces, and stronger disinfectants. Raw milk, cheese, and yogurt were discovered to contain rotaviruses and coronaviruses. Milk can preserve MERS-CoV. The animal's hygiene, diet, water, air quality, surroundings, and milking equipment affect milk's microbial makeup. Pasteurization reduces food-borne microorganisms in dairy products. SARS-CoV-2 can last on inanimate surfaces for many hours to several days, however there is no evidence of this. It spreads straight through the consumption of milk, food, eggs, and milk products. Though, understanding dairy product contamination sources and minimizing contamination pathways is always a good idea. The biggest logistical barrier to production was the difficulty in obtaining farming inputs, such as animal feed supplies (Zhang et al. 2020), animal equipment, such as milking machines, vaccinations, and other crucial production inputs, as well as cattle movements for pasture and water. Requests to remain in and social distance have had an impact on farm services that depend on providing humanitarian aid, including routine work and animal husbandry (low labor force, veterinary visits and services, and employees in product processing). Another barrier to completing the production cycle is the processing of animal products, such as milk and meat (delivery failure and declining processing and slaughtering capabilities), which forces farmers to lower output capacity and waste goods (Gortázar and de la Fuente 2020). The pandemic's effects on the livestock supply chain are still having an impact on the demand from consumers (misperceptions about the safety of animal products and decreased consumer income) as well as local and international marketing processes (reduced marketing opportunities, blockage of import/export activity, and lower purchasing power). The producers (farmers) run the danger of being unable to continue working in the field because of these disruptions in the livestock supply chain. The viability of livestock production systems and the availability of animal protein supplies have been gravely endangered by this predicament (FAO 2020a).

Potential and current alleviation measures

It has become urgently necessary to address the COVID-19 outbreak's effects on the viability of food supply networks to ensure global food security. As seen in this review, there exist hazards that endanger the sustainability of the cattle supply chain at each stage. Collaboration between numerous organizations, including governments, policymakers, non-governmental institutions, and scientists is necessary for the mitigation of these hazards. To maintain the functionality of livestock supply chains, numerous activities have been made from governmental and institutional perspectives to support livestock agricultural systems. These measures rely on: (1) facilitating the direct distribution of food/animal products to consumers (Brazil, Italy, Ghana, and the Philippines); (2) providing electronic marketing platforms (China and Morocco); (3) supplying inputs for livestock production, such as animal feeds, medications, and machinery (for example, the Italian authorities have purchased ultra-high-temperature (UHT) milk from dairy farmers); and (4) encouraging the restart of meat/milk processing businesses (China) (FAO 2020; Jackson et al. 2020; Rossi 2020).

Prospective alleviation methods that might increase the resiliency of the livestock supply chain have been suggested by the scientific community. One of the recommended techniques is to introduce new protein sources, such as insects, algae, and dairy-processing byproducts (such as whey proteins), to the food supply chain as substitutes for animal protein sources (Galanakis 2020; Matos 2020). Another ambitious approach uses tissue culture technologies to create animal muscle in vitro as an environmentally benign manufacturing method since farm animals' methane emissions will be decreased (Aleksandrowicz et al. 2016; Chriki and Hocquette 2020). However, it appears that these methods are not ethically and socially acceptable enough, and alternative methods of relief would be more practical. Farm animals, who make up the bulk of this food supply chain, should be better equipped to adapt to environmental challenges such as illnesses, subpar management, and abnormally low circumstances for wellbeing. One of the practical uses in this context should be enhancing animals' resistance to illnesses and hard environments while concurrently retaining acceptable production potential. The development of animals with more effective immune systems may indirectly lower production costs since less medicine and drug use, particularly antibiotic use, would be necessary (Hafez and Attia 2020). By lowering veterinary medication residues in animal products, this will also help consumers and human health (Soltan et al. 2018; Hashem et al. 2019). Furthermore, by reducing the need to cull or kill diseased or suspicious animals under pandemic breakout conditions, enhancing the immune system functionality of animals may help conserve the biodiversity of farm animals (Pal and Kerorsa 2020). Recent genetic advancements employing cutting-edge transgenesis and genome editing technologies, including CRISPR-Cas, may allow for quick genome modification of farm animals, producing animals that can successfully adapt to environmental and breeding problems (Tait-Burkard et al. 2018). Scientists have demonstrated the potential for these strategies to prevent a variety of infectious illnesses affecting farm animals, including ASF and bovine TB, in this period (Tait-Burkard et al. 2018).

Conclusion

In this review, we highlighted the considerable supply chain disruptions brought on by the COVID-19 outbreak in the areas of meat, milk, and animals. The COVID-19 pandemic showed us that, despite enormous progress in knowledge and informatics technologies, we still need to develop cutting-edge programs and safety precautions to protect the globe from pandemic calamities in the future. It is now obvious that pandemic catastrophes can involve food insecurity, economic crisis, rising poverty, and famines all around the world in addition to human health insecurity.

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Ethical statement

No ethical concerns were required for this study.

Availability of data and material

The data can be obtained from the corresponding author on reasonable request.

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Consent to participate

All the authors gave their consent for equal participation.

Consent for publication

All the authors gave their consent for publication.

Competing Interest

The authors declare that they have no relevant financial or non-financial interests to disclose.

Author Contribution

MS, MA, and MQ wrote the manuscript. DA, HN, and MUMC managed references. ZS, MM, MTA, and MKK revised the manuscript.

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