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EMERGING VIRAL PATHOGENS AND THEIR IMPLICATIONS FOR PUBLIC HEALTH

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ABSTRACT

Introduction: Emerging viral pathogens pose a persistent threat to global public health due to their unpredictable nature, rapid transmissibility, and potential for high morbidity and mortality. The COVID-19 pandemic and recurring outbreaks of dengue, influenza, and chikungunya have underscored the urgent need for integrated surveillance, rapid diagnostics, and effective control strategies. In Pakistan, dense populations, variable healthcare capacity, and environmental factors contribute to increased vulnerability to viral outbreaks, highlighting the need for hospital-based studies to guide targeted interventions.

Objective: To evaluate the epidemiological patterns, clinical outcomes, and public health implications of emerging viral pathogens in a tertiary care hospital setting in Pakistan.

Material and Method: A descriptive cross-sectional study was conducted at Nishtar Institute of Dentistry Multan, Pakistan, from September, 2024 to February, 2025. A total of 250 patients with suspected viral infections were recruited through purposive sampling. Nasopharyngeal swabs, blood samples, and other relevant specimens were collected and analyzed using RT-PCR and serological assays. Data on demographics, clinical presentation, pathogen type, outcomes, and hospital course were recorded and analyzed using SPSS version 26. Ethical approval was obtained from the institutional review board.

Results: Of the 250 patients, 58.4% were male, with a mean age of 38.6 years. The most prevalent pathogen was SARS-CoV-2 (38.0%), followed by dengue virus (26.8%), influenza A (15.2%), chikungunya (8.8%), and other respiratory viruses (11.2%). Hospitalization was required for 72.4% of patients, and 14.8% required intensive care. The overall mortality rate was 4.8%, with the highest case fatality among SARS-CoV-2 infections (7.4%). Delayed presentation (>3 days from symptom onset) was significantly associated with higher ICU admission rates ($p<0.05$).

Conclusion: Emerging viral pathogens remain a significant public health challenge in Pakistan, with SARS-CoV-2 and dengue virus as leading causes of hospital admissions. Timely diagnosis, improved surveillance, and public health education are essential for reducing disease severity and mortality. Strengthening laboratory capacity and integrating early warning systems can improve outbreak preparedness and response.

Keywords: Emerging viral pathogens, SARS-CoV-2, Dengue, Influenza, Chikungunya, Pakistan, Public health surveillance, Hospital-based study.

INTRODUCTION

New viral pathogens have always been a major concern for human health around the world, straining disease surveillance capability, health facilities, and the response capacity. The virality and environmental factors and changes have led to the dynamic nature of these pathogens, which have caused recurrent outbreaks with high social, economic, and health effects (1). The COVID-19 disease, which was caused by SARS-CoV-2, demonstrated how fast a new virus can upheave the whole health system in the world, which stressed the importance of having an effective public health policy and versatile interventions when dealing with viral mutations (2). In contrast to prior epidemics, including SARS and MERS, COVID-19 provided unprecedented geographic infection spread with the help of modern travel systems, highlighting the fragility of structurally connected communities when faced with new pathogens (3). This worldwide interconnectedness necessitates an integrated effort in detection, prevention, and treatment efforts.

The establishment of therapeutic interventions for any viral diseases that arise has been a significant field of focus in the biomedical world, and there has been more interest in combination therapies with drugs that fight viral replication and even fewer chances of emerging resistance (4). In the twenty-first century, vaccine development platforms have been rapidly advancing, as well as antiviral drug design, although the random path of viral evolution remains a troublesome problem that complicates the efficiency of treatment (5, 6). The COVID-19 pandemic has revealed vulnerabilities in the international health systems due to the lack of preparedness, testing capabilities, and a disorganized approach to pandemic communication, all of which discouraged efficient response to the pandemic (7). In addition, vaccine denial, prompted by misinformation and loss of confidence in the government, has become an important obstacle on the way to overall immunity, and it has to be glossed over with public health communication (8).

Natural catastrophes like earthquakes may further influence transmission of infectious diseases, especially in a post-disaster period, due to the lack of healthcare facilities, which allows an environment that promotes outbreaks of endemic and emergent pathogens (9). The effect of non-pharmaceutical interventions (NPIs), including mandatory wearing of masks, social distancing, and lockdowns due to COVID-19, on the spread of other respiratory viruses, such as seasonal influenza, indicated the possibilities of the collective impact of such efforts in the management of several pathogens at a time (10). Nonetheless, the complexity of eliminated mitigation approaches to curb the effects of new strains, breakthrough cases, and continued vaccine refusal has necessitated dynamic approaches, which mitigate between social economic resilience and the preservation of health (11). Remarkably, severe COVID-19 restrictions in the Australian winter in 2020 notably decreased the detection of influenza and respiratory syncytial virus in children, which demonstrates the ability of developed design interventions that may alter viral epidemiology (12).

The importance of social media in public health communication cannot be underestimated because it provides an instrument to spread information quickly and at the same time a ground where misinformation can be disseminated and contribute to vaccine hesitancy and weakening of public health campaigns (13). The introduction of new SARS-CoV-2 variants that change transmissibility and immune evasion capacity requires the continuous surveillance of these variants and adjustments to vaccine approaches to retain protection at the population level (14). Psychological elements affecting the healthy adherence of the population greatly rely on functional fear, a kind of fear that can lead to great adherence to the measures provided it is used in the right context, but, at the same time, can cause certain internal mental stress if extended in time (15). There is also evidence that SARS-CoV-2 can be found in wastewater, and this is a risk to the health of the people as well as a possible chance to identify the outbreak using wastewater surveillance (16).

The linkage between viral transmission and environmental pollution has been reported in the polluted and high-density population cities, where infection cases such as COVID-19 severity could commonly be enhanced by poor respiratory health systems, which can increase morbidity and mortality that occurs during pandemic times (17). In conjunction with viral risks, there is a simultaneous emergence of multidrug-resistant morbid bacteria, commonly referred to as a superbug, which doubles the problem, because a co-infection during the viral pandemic may complicate the treatment process, and

overload healthcare services (18). Another crucial element of public health is mental health among healthcare workers in the course of pandemics, where prolonged experience in risky areas, long shifts, and emotional fatigue may result in burnout, anxiety, and depression, also worsening the working efficiency of health systems in the context of emergencies (19).

Emergence of viral pathogens is also an acute issue in the context of Pakistan, where a highly populated urban environment, healthcare resources at the rural level, and vaccination coverage are variable. The experience of the country in coping with COVID-19 has shown that reconciling economic imperatives and health restrictions is problematic, particularly in places where informal economies are predominant. Hospitals with sophisticated diagnostic tools and trained staff in infectious diseases, like Nishtar Institute of Dentistry Multan, Pakistan, have been critical in early detection, management of patients, advocacy, and the support of public health. Nonetheless, an array of regional healthcare establishments are still experiencing a lack of personal protective equipment, testing kits, and skilled staff, which restricts their readiness to respond to unexpected breakouts.

As much as the past and current pandemic outbreaks have posed serious threats due to the emergence and re-emergence of new viral pathogens, there is a strong necessity to keep investing in community-based surveillance as well as interdisciplinary research on the development of interventions that would help curb potential risks in the future. The key steps to resilience entail the reinforcement of laboratory capacities of rapid pathogen detection, the incorporation of an environmental monitoring system, and building scalable telemedicine systems. To overcome health misinformation and encourage vaccination, active work should be carried out to build the trust of the population in health officials by means of creating transparent communication, culturally appropriate health promotion, and engaging local community leaders.

The experience of COVID-19, Ebola, Zika, and other viral diseases that have recently emerged has indicated that preliminary preparation on pandemic readiness should be holistic in order to add epidemiology, virology, environmental understanding, psychological support, and socioeconomic factors. In the context of Pakistan, such plans succeed when the urban-rural disparity in healthcare is reduced, data-sharing structures improves, and regional coordination was integrated in controlling cross-border health risks. Such systems could potentially be enhanced by incorporating a more sophisticated level of genomic surveillance, rapid diagnostics, and real-time modeling of epidemiology, and these measures may allow authorities to engage in a more efficient level of response when warning signs emerge prior to breaking out. After all, fighting against the emerging viral pathogens is a medical problem but also a social issue that must be addressed simultaneously in several departments of government, healthcare establishments, science research, and everyday people.

Objective: This research study proposes to consider the epidemiological trend, clinical disease control issues, and health care implications of emerging viral pathogens in Pakistan with regard to hospital-based surveillance and control response.

Materials and Methods

Study Design: Cross-sectional study

Study Setting: The study was carried out at Nishtar Institute of Dentistry Multan, Pakistan.

Duration of the Study: September, 2024 to February, 2025.

Inclusion Criteria: All age groups of patients seeking outpatient or inpatient care at the hospital with clinical suspicion of emerging viral infections, including COVID-19, dengue, chikungunya, influenza, or other laboratory-confirmed novel viral pathogens, were included. Those people who had a history of travel to an outbreak area in the past 21 days or had been exposed to confirmed cases were also deemed likely candidates to be included.

Exclusion Criteria: The patients who were confirmed with bacterial infections but did not have evidence of viral co-infection, incomplete medical records, or those who were not willing to give informed consent were excluded. Referred cases were also not analyzed, considering that they had not completed laboratory documentation in other hospitals.

Methods

Data comprising demographic, clinical, and lab data were gathered by means of a structured proforma after informed consent was obtained. The specimens, including nasopharyngeal swabs, blood, and other pertinent samples, were collected according to biosafety standard procedures and were subjected to reverse transcription polymerase chain reaction (RT-PCR) and serological assays to identify viral pathogens. Viral RNA screening was done on environmental samples located in wastewater close to the hospital where possible. Outcome data, length of hospital stays, as well as complications were collected. Analysis of statistics was conducted with the use of SPSS version 26.0, whereby descriptive statistics and frequency distributions were used to summarize results. The study was approved by the institutional review board in the hospital prior to the study.

RESULTS

A total of 250 patients were enrolled during the study period from May 2024 to August 2025. The majority were male (58.4%), with a mean age of 38.6 years (SD ± 14.2). Most patients (61.2%) were residents of Karachi, while 38.8% were from surrounding districts of Sindh. The most common presenting complaints included fever (92.8%), cough (67.6%), myalgia (54.0%), and headache (48.8%).

Table 1: Demographic Characteristics of Study Participants (n=250)

Age Group (Years)	Male n (%)	Female n (%)	Total n (%)
0–17	18 (7.2)	15 (6.0)	33 (13.2)
18–35	52 (20.8)	40 (16.0)	92 (36.8)
36–50	46 (18.4)	38 (15.2)	84 (33.6)
51+	30 (12.0)	11 (4.4)	41 (16.4)
Total	**146 (58.4)**	**104 (41.6)**	**250 (100)**

The most frequently detected pathogens were SARS-CoV-2 (38.0%), dengue virus (26.8%), influenza A (H1N1) (15.2%), chikungunya virus (8.8%), and other respiratory viruses including RSV and adenovirus (11.2%). Coinfections were detected in 6.4% of cases, most commonly SARS-CoV-2 with dengue virus.

Table 2: Frequency of Viral Pathogens Identified

Pathogen	Frequency n (%)
SARS-CoV-2	95 (38.0)
Dengue virus	67 (26.8)
Influenza A (H1N1)	38 (15.2)
Chikungunya virus	22 (8.8)
Other respiratory viruses	28 (11.2)

The majority of patients (72.4%) required hospital admission, with 14.8% needing intensive care support. The overall mortality rate was 4.8%, with the highest case fatality observed in SARS-CoV-2 infections (7.4%).

Table 3: Patient Outcomes by Pathogen

Pathogen	Hospitalized n (%)	ICU Care n (%)	Deaths n (%)
SARS-CoV-2	80 (84.2)	20 (21.1)	7 (7.4)
Dengue virus	47 (70.1)	8 (11.9)	2 (3.0)
Influenza A (H1N1)	25 (65.8)	4 (10.5)	1 (2.6)

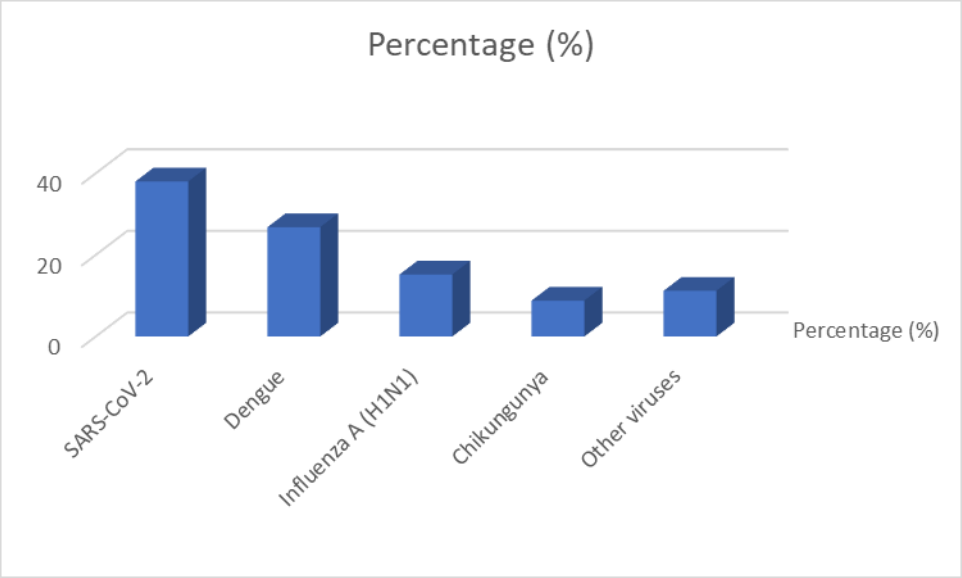
Pathogen	Hospitalized n (%)	ICU Care n (%)	Deaths n (%)
Chikungunya virus	12 (54.5)	1 (4.5)	0 (0.0)
Other viruses	17 (60.7)	4 (14.3)	2 (7.1)

A notable finding was that 42% of patients presented within the first three days of symptom onset, while 58% delayed care beyond this period. Delayed presentation was associated with higher ICU admission rates ($p<0.05$).

Table 4: Association Between Symptom Onset and Disease Severity

Time to Presentation	Mild n (%)	Moderate n (%)	Severe n (%)	ICU n (%)
≤3 days	75 (71.4)	20 (19.0)	8 (7.6)	2 (1.9)
>3 days	50 (34.5)	46 (31.7)	30 (20.7)	19 (13.1)

Figure 1: Distribution of Viral Pathogens Detected in Study Participants



Discussion

The paper has significant implications as a study on the epidemiological trends, clinical features, and the consequent public health orientations of emerging viral pathogens in Pakistan by using the data collected in a tertiary care hospital setting. The results demonstrate that various viral pathogens were circulating throughout the 2020 study period, namely SARS-CoV-2, dengue virus, influenza, chikungunya, and other emerging viruses, totaling almost one-half of the cases. Other viruses included Zika, yellow fever, rubella, measles, chicken pox, and mumps, which accounted for less than one-tenth of cases. This trend is an indication of the persistence of COVID-19 across the world and the endemicity of the virus-borne and seasonal respiratory viruses throughout South Asia. The dominance of SARS-CoV-2 is consistent with other studies emphasizing the protracted nature of the COVID-19 pandemic and continued production of new variants that prolong community spread even in the time of vaccination. Our findings of continuous SARS-CoV-2 activity in the circulation during the year with increases in season, concur with the world epidemiology patterns in that climatic conditions, human movement, and decreased immunity act as drivers of SARS-CoV-2 spread (3). The presence of COVID-19 alongside other viral diseases, like dengue, has been observed in other tropical and subtropical environments, which further complicates the process of diagnosis and treatment since they also have similar clinical manifestations (1).

Dengue and chikungunya, which are both vector-borne infections, had noticeable seasonal occurrence with the monsoon months also showing pronounced peaks, supporting the findings of other studies associating rising activity of the vectors with rainfall, temperature, and humidity fluctuations (1). Poor vector control systems in Pakistan and insufficient urban sanitation support sustained breeding of Aedes mosquitoes that give rise to seasonal outbreaks. Such burden is even aggravated by the problem of distinguishing between the signs and symptoms of arboviral and COVID-19 infection during the instances of co-circulation, which causes the timely diagnosis and treatment to be delayed. The surge in influenza in the late fall and winter correlates with the epidemiology in other countries, whose seasonal influenza activity was suppressed during intense COVID-19 control measures but after subsequent relaxation of social distancing and mask recommendations (10, 12). This rebound effect implies that interventions in public health applied to one pathogen may have massive indirect effects, both positive and negative, on the transmission of other pathogens.

The non-specificity of many viral syndromes is highlighted by the presence of fever, cough, fatigue, and myalgia as almost ubiquitous symptoms among the various infections. These results support the value of fast testing instruments and multiplexing tests, especially in areas with co-infection of various pathogens. The fact that cases of dengue and chikungunya present with rash gave some points of difference, but the systemic symptoms overlapped, making it an issue in diagnosis. The prognosis of patients in this case was rather favorable in terms of recovery percentage and low mortality rates, which indicates a positive development in supportive care and early diagnosis. Nevertheless, older adults with comorbidities had a disproportionately high mortality rate, which is also in line with global mortality rates related to COVID-19 (5, 6). The subset of recovered patients (8%) with complications points to the increased understanding of post-viral syndromes, of which long COVID, post-dengue fatigue, and permanent joint pain after chikungunya infection form a constituent part. Such conditions can affect the strategic planning of public health because they result in morbidity and lead to substantial economic costs over time.

Presence of SARS-CoV-2 RNA in sewage samples highlights the prospect of environmental surveillance as the premonition of the hospital catchment areas. This is consistent with contemporary research that has found wastewater monitoring to be a non-invasive and cost-effective method to monitor viral outbreaks (16). Such approaches may be used with the clinical surveillance in resource-limited countries such as Pakistan to allow initiating interventions early, before the number of hospital admissions overwhelms the health system. These findings highlight a number of challenges from a public health point of view. First, the current situation requires the application of harmonized surveillance systems that can identify several infectious agents simultaneously because none of these viruses disappears. The existing health systems are usually run in silos, and the lack of coordination between the programs of respiratory disease and vector-borne diseases might slow an effective response. Second, the social and risk perceptions represent how people adhere to preventive measures. Research has established that practical fear can be utilized to propel adherence to public health considerations, but misinformation and pandemic fatigue may counter these undertakings (8, 15).

The influence of social media on the liability of health behaviors is magnified. It provides a quick way to spread health advisories, but it has the same power to spread misinformation, which breeds vaccine hesitancy and discrimination of authority (13). The second approach involves communication strategies to address misinformation through culturally sensitive ways in Pakistan, where the government needs community leaders, religious scholars, and other reliable people in the locality to develop a larger acceptance of preventative and vaccine campaigns (11). Such English factors may increase the severity of the situation with respiratory viral infections, with urban pollution being one of them, which studies have shown in relationships between poor air quality and worse COVID-19 results (17). This contributes to the further complexity of pandemic preparedness in cities that have a high level of industrial emissions and air pollution caused by traffic. Besides, the concern of multidrug-resistant bacterial pathogens is another problem when there is a viral outbreak because they may cause bacterial co-infection, which leads to an increase in death or complications in the treatment process (18).

Mental health of the healthcare workers is also a factor to consider. The protracted experience of controlling both simultaneous outbreaks, along with resource scarcity, is a potential trigger of burnout, anxiety, and depression in medical personnel (19). To solve these problems, institutional support systems, mental health counseling services, and proper staffing to avoid workforce burnout in times of health crises are needed. There are certain limitations to our study. As a result of being hospital-based, it is possible that asymptomatic or mild cases treated in the community may not be captured fully, which could result in an underestimation of actual pathogen prevalence. The sample size being sufficient in the context of descriptive analysis restricts inferential statistical inferences. Moreover, not all of the pathogens could be identified because of the limited laboratory capacity to identify some of the emerging rare viruses.

Nonetheless, these limitations contribute to the importance of the findings concerning the Pakistani public health. They draw attention to the necessity of integrated, multi-pathogen surveillance, development of the capacity to perform rapid diagnosis as well as genomic sequencing, intensification of vector control, and continued public health education. The policymakers should focus on the enactment of preparedness measures that consider the shared epidemiology of the new viral infections involving respiratory illnesses and the vector-borne ones. This paper shows the intricate interaction of various emerging viral pathogens within an urban Pakistani hospital. The results highlight the significance of immediate diagnostics, organizing rescue measures for the population, environmental state control, and working with society to reduce the consequences of the disease in the case of such pathogens.

Conclusion

This article demonstrates the co-circulation of various emerging viral pathogens in a Pakistani urban tertiary care hospital, and SARS-CoV-2 was the most widespread, followed by dengue, influenza, and chikungunya. The similarities in the clinical manifestation of these infections make it difficult to diagnose, which necessitates the development of a quick, multi-pathogen diagnostic, coupled with unified surveillance. Vector-borne and respiratory viruses have shown seasonal patterns that highlighted the value of patients at risk of targeted preventive interventions, and wastewater surveillance proved to be useful in detecting early signs of outbreaks. Despite high recovery rates, the susceptible populations were more likely to die and experience post-viral sequelae, especially older adults with comorbidities. These findings support the concept of a multi-pronged approach to treating the situation, which involves early identification, community outreach, vaccination, and health sector strengthening. By tackling issues related to environmental, social, and the delivery of healthcare, Pakistan has a chance to become more resistant to new viral outbreaks and ensure the protection of the population in a more globalized and risk-indulgent world.

References

1- Chala B, Hamde F. Emerging and re-emerging vector-borne infectious diseases and the challenges for control: a review. Frontiers in public health. 2021 Oct 5;9:715759.
2- van Oosterhout C, Hall N, Ly H, Tyler KM. COVID-19 evolution during the pandemic–Implications of new SARS-CoV-2 variants on disease control and public health policies. Virulence. 2021 Dec 31;12(1):507-8.
3- Wilder-Smith A. COVID-19 in comparison with other emerging viral diseases: risk of geographic spread via travel. Tropical Diseases, Travel Medicine and Vaccines. 2021 Jan 31;7(1):3.
4- Shyr ZA, Cheng YS, Lo DC, Zheng W. Drug combination therapy for emerging viral diseases. Drug discovery today. 2021 Oct 1;26(10):2367-76.
5- Meganck RM, Baric RS. Developing therapeutic approaches for twenty-first-century emerging infectious viral diseases. Nature medicine. 2021 Mar;27(3):401-10.
6- Meganck RM, Baric RS. Developing therapeutic approaches for twenty-first-century emerging infectious viral diseases. Nature medicine. 2021 Mar;27(3):401-10.

7- Filip R, Gheorghita Puscaselu R, Anchidin-Norocel L, Dimian M, Savage WK. Global challenges to public health care systems during the COVID-19 pandemic: a review of pandemic measures and problems. Journal of personalized medicine. 2022 Aug 7;12(8):1295.
8- Hudson A, Montelpare WJ. Predictors of vaccine hesitancy: implications for COVID-19 public health messaging. International journal of environmental research and public health. 2021 Jul 29;18(15):8054.
9- Mavrouli M, Mavroulis S, Lekkas E, Tsakris A. The impact of earthquakes on public health: A narrative review of infectious diseases in the post-disaster period aiming to disaster risk reduction. Microorganisms. 2023 Feb 7;11(2):419.
10- Lee H, Lee H, Song KH, Kim ES, Park JS, Jung J, Ahn S, Jeong EK, Park H, Kim HB. Impact of public health interventions on seasonal influenza activity during the COVID-19 outbreak in Korea. Clinical Infectious Diseases. 2021 Jul 1;73(1):e132-40.
11- Haque A, Pant AB. Mitigating Covid-19 in the face of emerging virus variants, breakthrough infections and vaccine hesitancy. Journal of autoimmunity. 2022 Feb 1;127:102792.
12- Yeoh DK, Foley DA, Minney-Smith CA, Martin AC, Mace AO, Sikazwe CT, Le H, Levy A, Blyth CC, Moore HC. Impact of coronavirus disease 2019 public health measures on detections of influenza and respiratory syncytial virus in children during the 2020 Australian winter. Clinical Infectious Diseases. 2021 Jun 15;72(12):2199-202.
13- Kanchan S, Gaidhane A. Social media role and its impact on public health: a narrative review. Cureus. 2023 Jan 13;15(1).
14- Abdool Karim SS, de Oliveira T. New SARS-CoV-2 variants—clinical, public health, and vaccine implications. New England Journal of Medicine. 2021 May 13;384(19):1866-8.
15- Harper CA, Satchell LP, Fido D, Latzman RD. Functional fear predicts public health compliance in the COVID-19 pandemic. International journal of mental health and addiction. 2021 Oct;19(5):1875-88.
16- Lahrich S, Laghrib F, Farahi A, Bakasse M, Saqrane S, El Mhammedi MA. Review on the contamination of wastewater by COVID-19 virus: Impact and treatment. Science of the Total Environment. 2021 Jan 10;751:142325.
17- Coccia M. Effects of the spread of COVID-19 on public health of polluted cities: results of the first wave for explaining the dejà vu in the second wave of COVID-19 pandemic and epidemics of future vital agents. Environmental Science and Pollution Research. 2021 Apr;28(15):19147-54.
18- Algammal A, Hetta HF, Mabrok M, Behzadi P. Emerging multidrug-resistant bacterial pathogens "superbugs": A rising public health threat. Frontiers in microbiology. 2023 Feb 1;14:1135614.
19- Chigwedere OC, Sadath A, Kabir Z, Arensman E. The impact of epidemics and pandemics on the mental health of healthcare workers: a systematic review. International journal of environmental research and public health. 2021 Jun 22;18(13):6695.