

Transformative Effects of the COVID-19 Pandemic: A Review of Healthcare, Hygiene, and Behavioral Changes

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ABSTRACT

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Background: Coronavirus pandemic has yielded deep and far-reaching impacts across various areas, such as in healthcare, education, mental health, and the environment. It has tested systems and yielded both hindrances and opportunities for public health and social functions. **Objective:** This review seeks to scrutinize the multidimensional impact of the COVID-19 pandemic within certain areas, for example, telemedicine, hand hygiene, e-learning, antimicrobial resistance (AMR), mental health, gynecological health, and environmental changes. **Methods:** A thorough analysis and review of pertinent studies were performed to assess healthcare practice and behavior changes throughout and following the pandemic. Telemedicine use, hygiene practices, educational styles, use of antibiotics, mental health outcomes, and environmental impacts were all areas of particular interest.

Results: Telemedicine use grew extensively, especially among urban residents and chronic disease patients, though access was restricted in poor and rural populations. Hand hygiene had improved significantly during the pandemic but reduced afterward, indicating a need for continued public vigilance. E-learning grew immensely during lockdown periods but pointed to infrastructure and curriculum preparedness deficiencies. Mental health challenges such as increased anxiety and depression became more widespread and especially impacted women's gynecological health. Lifestyle modifications like more snacking and drinking also emerged. The pandemic imposed mixed environmental effects, with short-term improvements in air quality as well as drastic rises in medical waste.

Conclusion

The COVID-19 pandemic has drastically reshaped healthcare provision, education systems, and public health behavior. Although innovations such as telemedicine and e-learning offer long-term advantages, their effectiveness relies on overcoming infrastructural and equity issues.

Keywords: Coronaviruses, COVID-19, pandemic

INTRODUCTION

Coronaviruses belong to the group of RNA viruses known to cause respiratory problems, with signs and symptoms include common cold, fever, and cough in mammals and birds. In some cases, these viruses can cause serious and fatal conditions, which includes bronchitis, pneumonia and excessive acute respiratory syndrome. Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), whose preliminary cases originated from Wuhan, China, triggered a global health crisis. The estimate taken to stop the expansion of the virus have greatly impacted the lives of the general population. In relation to this, many trends have been changed in comparison to pre COVID-19 time(1, 2) .

The use of Telemedicine has become even more significant worldwide over the past two decades. It is a latest field and has gained significant popularity in COVID-19 pandemic (3, 4) . Throughout the pandemic period, the healthcare organizations were essential to change the way they provide care so, telehealth became a popular manner to get in touch with patients and meet their requirements. These technologies offer inventive opportunities for healthcare providers (5, 6). This is particularly important given recent research, in which researchers found that telehealth is becoming an option for healthcare providers as the pandemic continues and the severity of the disease increases(5) .

Without the existing vaccines or drugs and non-pharmaceutical interventions, which includes hand washing, social distancing, the make use of of hand sanitizer, and wearing face mask, are encouraged as the first line of fortification towards COVID-19 (4, 7, 8) . In general, handwashing is fundamental in

decreasing the unfold and spread of infectious illnesses, such as HIV-related infections, pneumonia, influenza, and ecological enteropathies(9-11). Hence, acquiescence with hand hygiene practice is essential to decrease the expansion of infection and to maintain the wellbeing and safety of the society (12). Prior studies have recommended that encouraging hand sanitation may be one of the majority cost-effective ways to reduce the universal burden of disease(13, 14) .

The C(15)OVID-19 outbreak brought about significant changes across various industries, mainly in the ground of education. It badly affects the education of 1.5 billion students therefore, following COVID-19 outbreak, schools became heavily reliant on e-learning inventions and tools to shift from in-person classes to e-learning education(16-18) . E-learning became very essential during that time as students heavily relied on that but the pandemic also highlighted many challenges and complications related to e-learning (11, 19-23). Also, various studies have been performed to identify environmental and behavioral changes in post COVID-19 time (24-27).

Antibiotics are the medicines used to control the growth of bacteria or to kill them (15, 28). These medicines are considered to be revolutionary but their irrational prescribing raises serious concerns in form of antimicrobial resistance (AMR) which is rising in developing countries(29) . WHO issues several guidelines to get control over AMR. Many studies have been performed to evaluate antibiotic prescribing patterns in pre and post COVID-19 time which furtherly gives more proper outlook of AMR and antibiotic prescribing patterns (30-32).

Epidemiological studies have shown that previous exposure to the virus can lead to long-lasting and persistent risks to mental health so, another important aspect of COVID-19 is psychological impact on the patients, their family members, their relatives and especially on the general public (33, 34). Several factors like lockdowns, social distancing and quarantine and the socio-economic effects leave a long-lasting impact in relation to this there may be expected rise in the psychological issues in general population in the period following the pandemic (35-38).

The pandemic affected the daily life of the people and also become the reason for unmanageable stress especially in case of women. This unmanageable stress can become the root cause of many gynecological problems in women(39, 40). Additionally, several studies with different methodologies have been conducted to try to recognize the impact of COVID-19 on maternal-fetal support and birth outcomes, fertility care, urogynecological services, and personal relationship dynamics. However, since December 2019, evidence linking COVID-19 to pregnancy has been speedily rising (41-44). A small number of studies have particularly raised concerns regarding gynecology (45). COVID-19 is mainly transmitted through respiratory droplets. The virus can also be found in other bodily fluids, including semen which raising concerns about its impact on male fertility (46, 47). Numerous studies have been carried out to find out the probable risks related to this(23, 48) . In general, many practices changed between the pre- and post-covid-19 era so, this review study hold account of the latest trends and practices.

METHODOLOGY

For this literature review, we did a systematic search using web dictionary like PubMed and Google Scholar, using keywords like: COVID-19, hygiene, telemedicine, menstrual changes, and environmental impact. As this paper focuses on changes post-COVID-19, the articles thus included are published in or after 2020. This review was completed using 30 studies in total. These comprised a diverse range of study designs, including 14 reviews, 8 cross-sectional studies, 1 observational study, 1 conceptual analysis, 2 surveys, 1 cohort study, 1 systematic review and meta-analysis, 1 descriptive and cross-sectional study, 1 observational and cross-sectional study.

The studies were drive in countries around the globe, including the United States, United Arab Emirates, Canada, Ethiopia, Turkey, Germany, and India, ensuring a broad geographical representation in this review article. The criteria for inclusion in these studies varied depending on the focus of each study, these include the relevance to the topic, participant characteristics such as country of residence, age, gender, and history of COVID-19 infection. Some of the exclusion criteria in the reviewed studies like being postmenopausal, previous history of hysterectomy and test positive for COVID-19 or other infections. The reviewed studies used both random sampling and convenience sampling for the selection of sample. Surveys included in the studies were generated through online platforms such as Type form. The reviewed articles obtained the data from renowned databases like PubMed, Cochrane Library, and Web of Science. The reviewed articles followed the guidelines provided by World Health Organization (WHO) and the ideal Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). The data analysis in the reviewed studies was done using

software like SPSS and statistical tests like T-test, Chi-squared test and Wilcoxon signed-rank test.

RESULTS

The table illustrates a summary of the research findings in several key areas regarding the effects of the COVID-19 pandemic.

Tele medicine :Trends and Challenges

Telemedicine utilization increased, throughout the COVID-19 era especially among doctors who manage chronic conditions. Women, middle-aged practitioners, and those in urban regions were more likely to utilize telemedicine. But disadvantaged and marginalized communities have hurdles such as poor internet access. Video consultations amplified these disparities. Targeted initiatives are needed to address barriers and prevent telemedicine from exacerbating healthcare inequalities (49).

Telemedicine use decreased as people returned to in-person consultations post-pandemic due to socioeconomic barriers, regulatory challenges, and concerns over cybersecurity and patient privacy (50).

Telemedicine was found effective in diagnosis, therapy, emergency treatments, and rehabilitation but posed with legal, infrastructure, poor internet, and unavailability problems. It is significant to maintain an update in standardized protocols with guaranteed technology to help it fully fulfill its role (51). This study looks at how patients in rural Ontario used telemedicine pre pandemic and throughout the COVID-19 emergency. Telemedicine is adopted at higher rates in areas with lower rural density than in more rural regions, particularly those with chronic diseases and elderly patients. These results show how access to healthcare can be enhanced by telemedicine, but these results also focus on the

need to remove hurdles experienced by rural communities. To check out these hurdles, assess the telemedicine effects on endangered rural populations' health outcomes and treatment quality, and compare it to in-person care, more research is required (52-54).

Hand Hygiene Trend before and after COVID

When the WHO officially declared COVID-19 a pandemic in May 2020, the frequency of hand washing saw a significant increase, rising from an average of 4 times to 8 times a day. Throughout the pandemic, approximately 96% of respondents reported washing their hands between 6 to 12 times daily. However, after the pandemic, this frequency dropped back to 4 to 7 times a day for over 92% of the respondents (55).

A study conducted in Korea revealed a decline in the use of bar soap, from 71.8% to 51.4%, while the usage of liquid hand-soap rose from 23.5% to 41.3%, and the use of hand sanitizer also saw an increase. The typical handwashing duration grew from 20.16 seconds to 31.58 seconds, and the daily handwashing frequency increased from 6.96 times to 9.98 times following the pandemic (55).

Around 94% participants (students) were knowledgeable about hand hygiene, only about 52% knew that handwashing with soap and water is the most effective method. Participants exhibit high hand hygiene practices, post COVID with an average score of 86.8%. However, before the COVID were lower (62%) (56).

Overall adherence to hand hygiene was 52%. The lowest rates were noted after touching patients' surroundings (40%) and before patient contact (43%), while the highest adherence rate was seen after patient contact (76%). Physicians had an adherence

rate of 45%, whereas nurses showed a higher rate of 61% (57).

Post COVID education and learning

Post COVID education system faces a critical moment to transform its teaching methods, curriculum, and structure in response to technological advancements and global changes. The COVID-19 era provided a chance to reconsider about the time and place of learning. By combining online and blended learning models, integrating synchronous and asynchronous methods accessibility to education is enhanced. Education can become more engaging and globally interconnected. Schools must prepare students for an unpredictable future while ensuring education remains effective, impactful and relevant (58, 59). This article investigates the development and implementation of e-learning technologies before and after the COVID-19 pandemic analyzing it through the Technology System Evaluation Theory (TSET) and the combined Theory of acceptance and Use of Technology (UTAUT). It finds that before the pandemic focus was on adoption of technology while after pandemic focus shifted to efficiency of technology. COVID 19 crisis pushed for improved infrastructure so that e-learning reach a wider audience, making it essential. However, Limited financial resources hindered implementation of new technologies (60).

The research emphasizes the need and importance of adjusting and revising curricula to promote online learning beyond academics, promote student association through online discussion platforms, and promote strong connections between online service providers and students.

The results revealed that while effort expectancy did not affect students' aim to go on with online learning post-COVID-19, social influence, performance

expectancy, and fulfillment had a significant influence on this intention(60)

AMR and antibiotic prescribing after COVID

The COVID-19 pandemic exacerbated AMR, which occurs due to the overuse of antibiotics, leading to a 15% increase in MDR infections. Biofilm formation on invasive devices increased the risk, with notable resistance in gram-negative bacteria (61).

The effect of COVID-19 on AMR was complex. Resistance to Gram-positive bacteria, such as MRSA and VRE, was stable, while fungal infections from *Candida* and *Aspergillus* species increased, with some strains developing antifungal resistance. The overuse of antibiotics in hospitals, particularly among COVID-19 patients, caused outbreaks of multidrug-resistant *Acinetobacter baumannii* and *Klebsiella pneumoniae*. Overuse of PPEs and disinfectants also promoted the advancement of AMR (61).

More than 78% of patients with COVID-19 worldwide received antibiotics, which indicates the overuse of antibiotics in both developed and developing countries. The most commonly prescribed medications for patients with COVID-19 were azithromycin and other broad-spectrum antibiotics, with significant increases in polymyxin B, daptomycin, amikacin, and amphotericin. The intake of antibiotics in the ICUs was broadly escalated during the pandemic (62). This study assessed the pattern of antibiotic prescriptions at a faith-based hospital in Zambia post-COVID by using WHO prescribing indicators and the Aware classification system. The results were that 51.9% of patients were prescribed 578 antibiotics. These included 34.9% who received one antibiotic, 13.6% who received two, and 3.4% who received three. Amoxicillin, metronidazole, and ciprofloxacin were among the most frequently prescribed antibiotics with 23.4%, 17.1%, and 8%, respectively. Less frequently prescribed antibiotics

included ceftriaxone and doxycycline. Nitrofurantoin, which is the drug for urinary tract infections, was very seldom prescribed at 0.3% (63).

Pst COVID Pschycological Impact

Following the quarantine, many people suffer from emotional instability, anger, insomnia, sadness, and signs of stress disorder after trauma. Depression, rage, anxiety, alcohol misuse, and changes in behavior such as avoiding overcrowded areas and washing hands carefully are just a few of the long-term effects(63). Total 1,871 people participated in the survey, and the results revealed some troubling trends. Many participants reported struggles with their mental health, with 38.2% experiencing anxiety and 10.5% dealing with depression. Overall, 40.5% of respondents were dealing with either anxiety or depression. Additionally, 74.1% said they felt stressed, and 71.7% reported not feeling emotionally well. The findings highlight that many people are facing anxiety and depression, largely because of the impact of lockdowns. Many healthcare professionals experienced significant psychological challenges due to COVID. Symptoms like insomnia, anxiety, and depression, were used to assess their mental health. The analysis showed that female healthcare workers were more prone to develop anxiety and depression. Frontline workers faced much higher rates of these issues compared to those in non-frontline roles. Additionally, nurses were more affected by anxiety and depression than doctors (63).

Pst COVID Pschycological Impact

In this study women participants were 1031. From the beginning of the COVID pandemic some observed changes in their menstrual cycles. Some noticed worsening in their premenstrual symptoms, while a few women experienced issues such as heavy periods (menorrhagia), more painful periods

(dysmenorrhea) or missing period as compared to before pandemic. In this study women participants were 1031. From the beginning of the COVID pandemic some observed changes in their menstrual cycles. Some noticed worsening in their premenstrual symptoms, while a few women experienced issues such as heavy periods (menorrhagia), more painful periods (dysmenorrhea) or missing period as compared to before pandemic. The studies included in this research recommend that the infection of SARS-CoV-2 and the pandemic may be linked to several issues affecting women. These include menstrual irregularities, changes in contraception use, disruptions in steroid hormone levels, modifications in urogynecological care, impacts on mental wellbeing of women, and a rise in violence against women (64).

DISCUSSION

The COVID-19 pandemic served as a driving force for significant changes covering various sectors, altering established practices and revealing significant weaknesses. Areas like telemedicine, hand hygiene, e-learning, antibiotic usage, mental health, gynecological issues, and behavioral trends have experienced substantial transformations because of the distinct challenges presented by the pandemic. While these changes have opened up opportunities for innovation and greater accessibility, they have also focused on systemic gaps, inequalities, and new risks (65). This discussion explores the complex effects of the pandemic, looking at both the progress made and the ongoing challenges in these areas, with an emphasis on their implications for future resilience and sustainability. The research done on telemedicine throughout and later in the COVID-19 era indicates that although it has the potential to change how healthcare would be delivered, it has quite a number of challenges. According to research, the pandemic has contributed

greatly towards the growth of telemedicine especially in the chronic condition psychotherapy and the endocrinology where the patients are now getting care they couldn't due to lack of geographical cohesion.

The available literature pertaining to the hand hygiene practices performed prior, during and later than the COVID-19 pandemic mentions a great variation in the hand hygiene practices across different settings in terms of the frequency and the technique. Ali et al (2023), and Choi et al (2021) note cases of excessive hand washing during the onset of the pandemic along with a noticeable rise in the utilization of hygiene products. Conversely, Ali et al (2023) highlight a surge in handwashing frequency specifically during the pandemic from 4 times during an average day to 8(9). The post-election research on e-learning and education shifts how education is perceived, adopted, and practiced after the COVID 19 pandemic. Based on the results presented in Zhao and Watterston (2021), the pandemic has provided a chance for the education system to transform the way it has traditionally approached the concepts of teaching and learning (66). The COVID-19 pandemic has led to huge psychological trauma to many populaces, the public, health workers and those in quarantine being some of the affected groups. Amongst them, the studies conducted emphasize the number of mental health issues that were already rampant but were worsened by the pandemic and the extent to which it affected the person varied based on societal roles and personal barriers.

CONCLUSION

The COVID-19 pandemic served as a transformative duration that changed practices and viewpoints across many sectors. Telemedicine has arisen as a

capable approach to the challenges of healthcare availability, but it faced significant obstacles in achieving equitable implementation, particularly for rural and underprivileged communities. Hand hygiene practices saw a peak during the pandemic but have since declined, highlighting the importance of ongoing awareness, adherence, and compliance, especially in healthcare environments. E-learning showed its potential to transform education through online and hybrid models, but its scalability needs systemic support and innovative curriculum. The overuse of antibiotics throughout the pandemic worsened antimicrobial resistance, stressing the necessity for stricter prescription guidelines and stewardship. The psychological and behavioral impacts were significant, with rising mental health issues and shifts in lifestyle behaviors underscoring the long-term effect of the pandemic. Post-COVID gynecological health exhibited complex modifications, from menstrual irregularities to shifts in sexual behavior and birth control use, necessitating comprehensive healthcare approaches and strategies. Collectively, these findings emphasize the essential significance of addressing inequalities, fostering sustainable practices, and enforcing strong policies to mitigate lengthy-term unfavorable results and strengthen resilience in future crises.

Declaration of conflict of interest

The authors declare no conflict of interest, financial or otherwise. No artificial writing assistance was utilized in the production of this manuscript.

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