Journal of Health Research
eISSN 2586-940X

Volume 37 | Issue 2 Article 2

2023

The COVID-19 Pandemic in South Asia: A Comprehensive Review of the Genomic Variations, Epidemiological Features, Diagnosis, Treatment and Preventive Schemes

Abdullah Al Noman
BioScience Academy Bangladesh, Dhaka, Bangladesh ; Department of Genetic Engineering & Biotechnology, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore, 7408, Bangladesh

Jannatul Efte Ekra
BioScience Academy Bangladesh, Dhaka, Bangladesh ; Department of Biochemistry and Molecular Biology, Faculty of Life Science, Mawlana Bhashani Science and Technology University, Tangail, 1902, Bangladesh

Rima Islam Meem
BioScience Academy Bangladesh, Dhaka, Bangladesh ; Department of Genetic Engineering & Biotechnology, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore, 7408, Bangladesh

Sujan Islam
BioScience Academy Bangladesh, Dhaka, Bangladesh ; Department of Biochemistry and Molecular Biology, Faculty of Life Science, Mawlana Bhashani Science and Technology University, Tangail, 1902, Bangladesh

Fariha Sharzana
BioScience Academy Bangladesh, Dhaka, Bangladesh ; Department of Genetic Engineering & Biotechnology, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore, 7408, Bangladesh

Shofiqul Islam
BioScience Academy Bangladesh, Dhaka, Bangladesh ; Department of Genetic Engineering & Biotechnology, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore, 7408, Bangladesh

Samiron Sana

BioScience Academy Bangladesh, Dhaka, Bangladesh ; Department of Pharmacy, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore, 7408, Bangladesh ; Pharmacy Discipline, Life Science School, Khulna University, Khulna, 9208, Bangladesh

Masnoon Kabir
International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, B), Dhaka, Bangladesh

Niaz Mahmud
Department of Nutrition and Food Technology, Jashore University of Science and Technology, Jashore, 7408, Bangladesh

Abdullah Al Mahedi
Faculty of Medicine, Chittagong Institute of Medical Technology, Chattogram, Bangladesh

Taufique Joarder
Public Health Foundation, Bangladesh

REVIEW

The COVID-19 Pandemic in South Asia: A Comprehensive Review of the Genomic Variations, Epidemiological Features, Diagnosis, Treatment and Preventive Schemes

Abdullah Al Noman [a,b], Jannatul Efte Ekra [a,c], Rima Islam Meem [a,b], Md. Sujan Islam [a,c], Fariha Sharzana [a,b], Md. Shofiqul Islam [a,b], Samiron Sana [a,d,e,*], Niaz Mahmud [f], Md. Masnoon Kabir [g], Abdullah Al Mahedi [h], Taufique Joarder [i]

[a] BioScience Academy Bangladesh, Dhaka, Bangladesh
[b] Department of Genetic Engineering & Biotechnology, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore, 7408, Bangladesh
[c] Department of Biochemistry and Molecular Biology, Faculty of Life Science, Mawlana Bhashani Science and Technology University, Tangail, 1902, Bangladesh
[d] Department of Pharmacy, Faculty of Biological Science and Technology, Jashore University of Science and Technology, Jashore, 7408, Bangladesh
[e] Pharmacy Discipline, Life Science School, Khulna University, Khulna, 9208, Bangladesh
[f] Department of Nutrition and Food Technology, Jashore University of Science and Technology, Jashore, 7408, Bangladesh
[g] International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, B), Dhaka, Bangladesh
[h] Faculty of Medicine, Chittagong Institute of Medical Technology, Chattogram, Bangladesh
[i] Public Health Foundation, Bangladesh

Abstract

Background: **The purpose of the study was to outline the genomic and epidemiological characteristics of COVID-19 in South Asian countries as well as the diagnosis, treatments, and prevention approaches undertaken by these countries to tackle the COVID-19 pandemic.**

Methods: **We searched electronic databases such as Google Scholar, PubMed, and Scopus as well as various national and international COVID-19 websites, WHO databases, and electronic media. 63 articles were included from databases and 34 articles from various other sources.**

Results: **Scientists observed genomic variations including common mutations in ORF1ab, ORF1a, ORF3a, and S genes, while several unique mutations exist in most isolates from these countries. Demographic analysis showed that the majority of infected individuals were male and younger adults (20−40 years). India had the highest number of deaths and incidents while Afghanistan had the highest fatality rate (4.37%). Various molecular assays including rRT-PCR, antigen and antibody-based assays have been developed and pre-existing treatments have been used to combat the pandemic. Although every country tried to implement imperative preventive measures along with vaccination drives, many of them still face grave repercussions due to impoverished health systems, underdeveloped infrastructures, and improvident government policies.**

Conclusion: **To our knowledge, this is the first review appraising various features of SARS-CoV-2 and COVID-19 that persists in South Asia and strategies undertaken by the countries to tackle the disease. This review will facilitate timely interventions for future novel outbreaks in the region.**

Keywords: COVID-19, South Asia, Genomic variations, Epidemiology, Diagnosis, Prevention

Received 20 May 2021; revised 22 July 2021; accepted 8 September 2021.
Available online 20 July 2022

* Corresponding author.
E-mail address: samironsana@gmail.com (S. Sana).

https://doi.org/10.56808/2586-940X.1018

1. Introduction

COVID-19 began as an unprecedented outbreak of pneumonia that originated in China and was declared a pandemic later. The virus was later named Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) [1,2]. The World Health Organization (WHO) announced Coronavirus disease-2019 (COVID-19) as the name of the disease and identified it as a threat to global public health on 30 January 2020 [2]. It is the seventh of the already identified respiratory syndrome disease-causing human coronaviruses. The epidemic causing SARS-CoV in China and the MERS-CoV in the Middle East are the two other coronaviruses that previously endangered human lives [3,4]. The genome of SARS-CoV-2 is composed of RNA, and thus evolves through mutations more often than the DNA virus. Hence, it demonstrated continuous and unique mutations which made it more difficult to suppress [5]. At first, mutations in the spike protein (e.g. D614G, Y453F) were considered most dangerous because the virus infects the host cell with the spike protein [6]. However, since then, numerous distinct mutations have been found in various regions of its genome. As of now, four variants have been identified: the Alpha variant (B.1.1.7 from the UK), the Beta variant (B.1.351 from South Africa), the Gamma variant (P1 from Brazil), and the Delta variant (B.1.617.2 from India) [7].

According to the WHO, more than 188.6 million infected cases and over four million deaths have been reported with a fatality rate of 2.15% as of 16 July 2021. The USA is the most affected country to date with 33.6 million confirmed cases, constituting almost 18% of all cases, and 603,170 deaths as of 16 July 2021 [8]. The South Asian countries (SAC) have also been devastated by this highly infectious disease. In particular, densely populated countries like India and Bangladesh are more susceptible to the virus. As a result, these countries face grave challenges in tackling the virus. As of 16 July 2021, a total of 34,300,319 people have been infected and 472,726 have lost their lives in the region [9]. Despite various precautionary measures, the "Second Wave of COVID-19' has struck South Asia massively. Additionally, rapid and unpredictable mutations made it difficult to tackle the virus, despite vaccination drives.

To the best of our knowledge, this is the first review article that aims to discuss genomic alterations and epidemiological patterns of COVID-19 in South Asia. Besides diagnostic methods used, treatment and preventive tactics for COVID-19 taken by the countries in South Asia were also our issues of interest. Appraising these topics is a matter of urgent concern. Hopefully, countries that have been affected severely can adopt the policies of the countries that have successfully controlled the spread of COVID-19 and avoided the worst ramifications of COVID-19.

2. Methods

A comprehensive search was conducted following the methods of a previous study [10]. We searched electronic databases such as PubMed, Scopus and Google Scholar for published articles using the combination of the following terms including the name of the countries of South Asia, "COVID-19," "coronavirus,'' "Genomes," "Diagnostic systems," "Epidemiology,'' "Treatments,'' "Prevention strategies," We identified a total of 677 articles by initial searching. After screening and assessment, 63 articles were considered. To make the scope broader, a quality assessment was not performed. Other necessary articles were retrieved from WHO databases and national and international websites dedicated to COVID-19 information and electronic media because of the unavailability of information from database articles. Finally, information was discussed and reported in this study. Fig. 1 illustrates the search strategy and method applied.

2.1. Ethical approval and consent for publication

Not applicable.

3. Results

3.1. Genomic features

Genetic variations analysis of SARS-CoV-2 suggests that like all RNA viruses, it contains numerous mutation frequencies. India sequenced the maximum number of SARS-CoV-2 genomes (973) among SAC, followed by Bangladesh (415), Pakistan (260), Nepal (11), and Sri Lanka (4) as of 1 June 2021 [11]. Afghanistan, Bhutan, and the Maldives have not reported any genome sequencing yet.

A study on 184 SARS-CoV-2 genomes from Bangladesh found 634 mutations that include 274 non-synonymous amino acid (AA) substitutions in 22 different proteins. AA mutations were prevalent at 48 different positions of the papain-like protease (nsp3). Moreover, nine unique mutations were observed in comparison with global strains in the spike proteins [12]. Another investigation of 371 genomes identified 4604 mutations, including 2862 missense, 1192 synonymous, and 25 INDEL

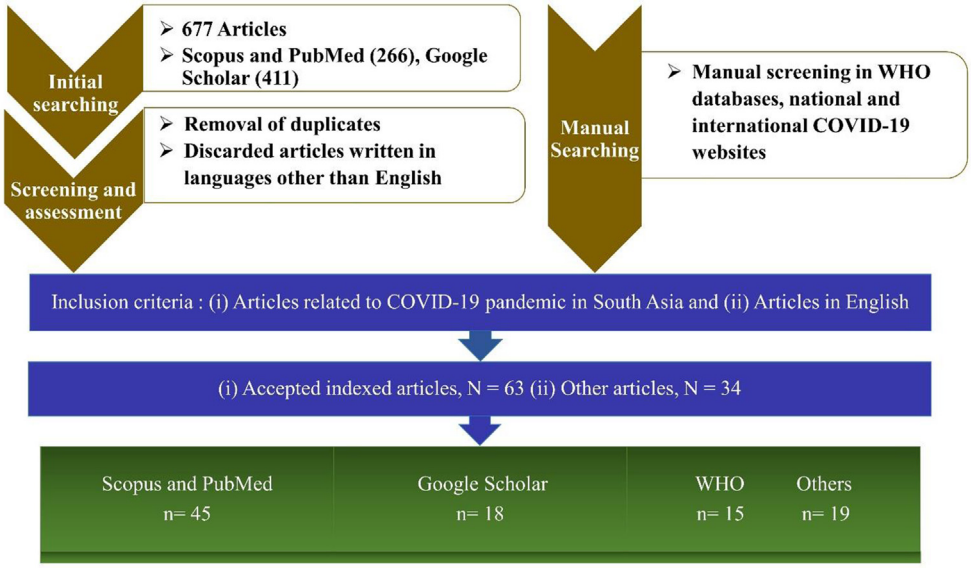

Fig. 1. Flow diagram of the search strategy.

(insertion and deletion) mutations. Phylogenetic analysis implicated that the virus originated from Europe and the GR clade was most prevalent. Another significant finding in these SARS-CoV-2 genomes was 34 unique alterations of AA in various proteins [13].

A study of 566 Indian genomes found 3384 unique point mutations, including substitution (933) and INDEL mutations (2451). Additionally, 64 single nucleotide polymorphisms (SNP) were found. Of them, 57 were present in six coding regions, and 7 were present in 5′-UTR and 3′-UTR [14]. Another comparative study found that all the identified clades of SARS-CoV-2 were present in the study population and 19B had the highest occurrence. In the viral spike protein, D614G mutation was predominant [15]. Additionally, the whole-genome sequence phylogeny and the patient's itinerary implicated the origin of Indian strains from the Middle East and Europe [16].

The genomes from Nepalese isolates were more than 99.99% identical to two previously sequenced SARS-CoV-2 genomes (MN988668 and NC_045512) from Wuhan, China. Moreover, five mutations including both silent and non-synonymous mutations were identified in ORF1a, ORF1b, ORF8b, and nucleocapsid based on the reference sequence EPI_ISL_405839 [17].

Full and partial genome sequencing of eight Pakistani isolates showed that the earlier prevailing viral strains were clustered with strains from Saudi Arabia, India, the United States, Australia, and China. Of the eight strains, five were GH clade that contains mutations in the S protein and Ns3 gene, three were L, two were S and one was I clade. Furthermore, the ORF1ab variant L3606F was observed in one GH and one L strain, which implicated evolutionary transitions of the virus [18]. Four whole-genome sequences of a study identified 31 variants, including deletion in ORF1ab, ORF1a, and N genes that have functional roles in replication and translation of SARS-CoV-2. Mutations in N & ORF1a proteins showed alterations at the AA level [19].

Phylogenetic analysis of four Sri Lankan isolates found clusters of mostly European strains. SNP analysis revealed that the genome sequences had different variations compared to the reference genome, such as variations in the six nucleotide, five nucleotide, and four nucleotide positions. Moreover, AA variants were found in the ORF1ab protein, S protein, ORF3a gene, M gene, and N protein of all four whole-genome strains [20].

3.2. Epidemiological characteristics

India, Pakistan, and Bangladesh are the three countries with the highest occurrences and deaths in South Asia. Nearly 91% of the infected individuals were from India. Although Afghanistan had a comparatively lower incidence, testing rates were also the lowest in this country. So, it might be possible that many cases in Afghanistan were not identified. Moreover, Afghanistan had the highest fatality rate (4.37%), followed by Pakistan and Bangladesh. Bhutan had the lowest number of infected patients and deaths; cumulatively, 1309 individuals were infected, while only one died in the country. Meanwhile, 33,102,065 of the patients from

Table 1. Case distribution and vaccination of COVID-19 in South Asian countries.

Country	Total confirmed cases	Total deaths	Mortality rate	Total Recovered	Recovery rate	Number of vaccine doses administered
Afghanistan	139,051	6,072	4.37	86,219	62.0	1,024,168
Bangladesh	1,084,922	17,465	1.60	911,643	84.0	10,554,425
Bhutan	2,398	2	0.08	2,038	85.0	486,126
India	31,064,908	413,091	1.33	30,227,792	97.3	394,978,565
Maldives	75,736	216	0.29	72,930	96.3	561,748
Nepal	664,576	9,506	1.43	628,243	94.5	3,589,051
Pakistan	986,668	22,760	2.30	918,329	93.1	21,660,650
Sri Lanka	282,060	3,614	1.29	254,871	90.4	5,720,328

these countries recovered from the disease by 16 July 2021. In Table 1, the highest recovery rate was observed in India (97.3%), while Afghanistan had a relatively low recovery rate (62%).

Due to the rapid spread to a large population, it was difficult to maintain a complete database that included every individual. Existing demographic data analysis showed that variations existed among the different age groups of COVID-19 cases in SAC excluded Bhutan (Demographics data was not available and unspecified cases are not indicated) (Fig. 2). The majority of the infected patients were young adults aged between 20 and 40 years, except in Sri Lanka, where the majority of the patients were aged 40–49 years [21–27]. There is no scientific evidence yet explaining the higher infection rate among the younger population. However, it is easily perceivable that younger people may be more likely to avoid preventive practices, such as using face masks, maintaining social distance, and quarantining after potential exposure.

Regarding gender distribution, males had a higher infection rate (Fig. 3) than females. Previous literature showed that females are genetically and immunologically more resistant to SARS-CoV-2 infection. The X chromosome has elevated immune regulating genes, and females possess double X chromosomes [28]. The virus utilizes angiotensin-converting enzyme 2 (ACE-2) as both receptor and the route of infection. Studies found that Asian males have elevated expression of ACE-2 receptors compared to females. Also, female ovaries had much lower levels of ACE-2 than testes [29,30]. Moreover, men were more vulnerable to cytokine storm syndrome occurring in response to SARS-CoV-2 attack. This occurs because men have a higher likelihood of producing cytokines resulting in cytokine storms [27]. Several social and cultural

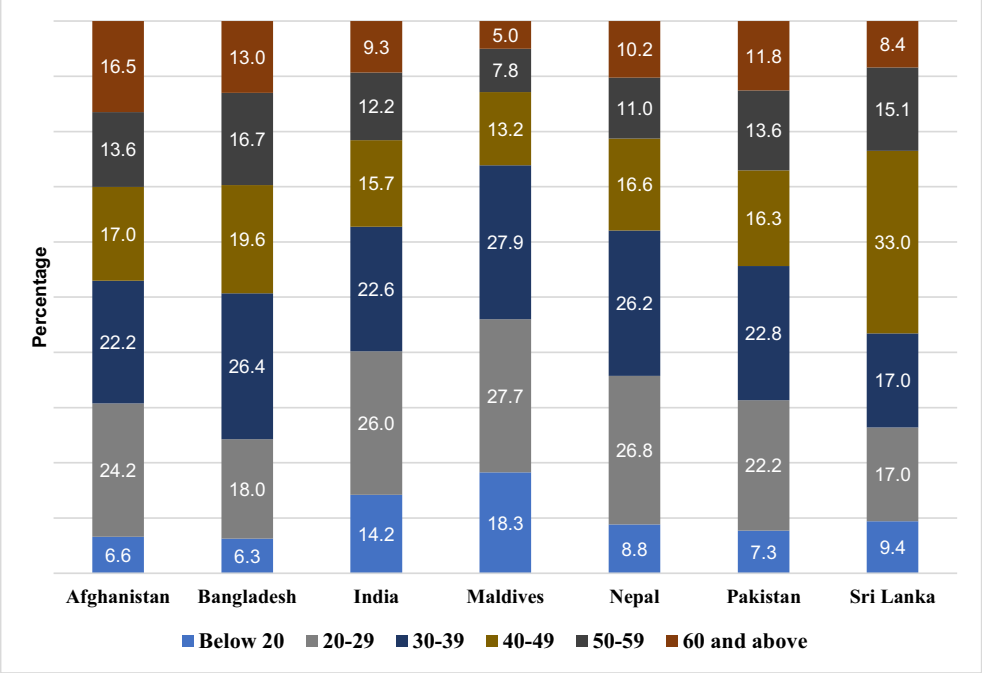

Fig. 2. Age distribution of COVID-19 infected patients in South Asian countries.

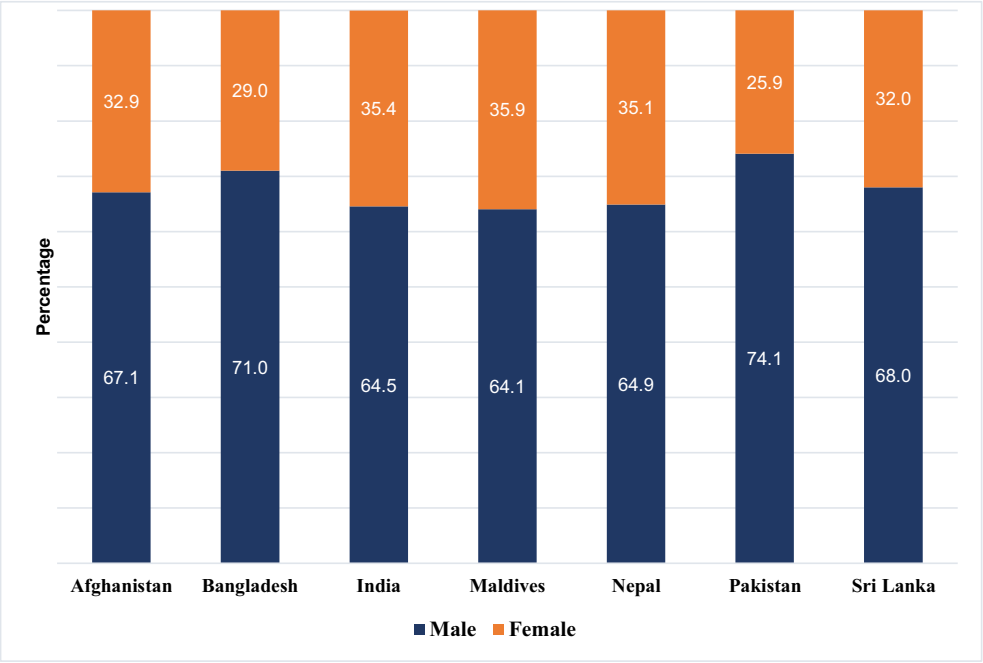

Fig. 3. Sex distribution of COVID-19 infected patients in South Asian countries.

factors are also deemed to be responsible. For example, smoking, tobacco use, and alcohol consumption are more prevalent in men [30]. Moreover, females were more aware of the hygiene practices to prevent COVID-19 and adopted precautionary measures more early than men [31].

3.3. Diagnostics approaches

Since the onset of the pandemic, many countries had been trying to overcome it through various courses of action. Of these, diagnostic measures have received prime attention. Different molecular tests including the real-time reverse transcriptase-polymerase chain reaction (rRT-PCR) and serological tests such as the rapid diagnostic test (RDT), Enzyme-Linked Immunosorbent Assay (ELISA), neutralization assay, and chemiluminescent immunoassay are being used [32]. The rRT-PCR of nasopharyngeal swabs or oropharyngeal swabs is considered the 'gold standard.' Various protocols have been uploaded to WHO technical guidance [33]. A majority of the SAC focused on increasing the number of rRT-PCR labs with well-equipped amenities, as well as producing cost-effective kits along with various molecular and serological assays. The detection of this viral RNA is highly specific but it is less sensitive in some cases which can take a relatively long time and may produce false-negative results. Yet, rRT-PCR is still the most widely used and most accurate method for the detection of SARS-CoV-2 [34]. Table 2 lists the diagnostic methods that were approved for use in SAC.

India had the highest number of diagnostic labs (2750), including 933 TrueNat and 132 CBNAAT labs as of 16 July 2021, albeit it still struggling to meet the demand [35]. Most of the countries were very far from testing and screening all the suspected cases. Afghanistan was conducting only 9,064 tests per million population, which is the lowest rate in South Asia, followed by Bangladesh (29,214 tests/1,000,000 population) and Pakistan (46,812 tests/1,000,000 population) as of 6 April 2021 (Fig. 4) [36].

3.4. Treatment and interventions

In Afghanistan, a controversial drug containing addictive substances including morphine and codeine became a topic of considerable discussion as a potential treatment for COVID-19among the general public. Although the government and health experts warned against this unproven drug, people burst with excitement for the medication [51]. The country is facing grave repercussions due to inadequate and substandard treatment facilities. The government also faced difficulties meeting the required number of healthcare professionals and protective equipment. There was a preponderance of health care workers who had to purchase PPE even though their salary was very low. A large number of hospital-acquired infections were caused by the virus [52].

Table 2. COVID-19 diagnostic methods in South Asian countries.

Country name	Screening Method	Synopsis	References
Afghanistan	rRT-PCR	Sample: Nasopharyngeal swab, oropharyngeal swab, sputum and/or bronchoalveolar lavage.	[37]
	rRT-PCR	Sample: Nasopharyngeal swab, oropharyngeal swab, sputum, and/or bronchoalveolar lavage.	[37]
Bangladesh	GeneXpert Covid-19 Test	Sample: Saliva. Detects E gene and N2 region of the N gene of SARS-CoV-2 Result: within 50 minutes.	[38,39]
	Rapid Dot Blot	Sample: Saliva and swab Result: within 15 minutes Reliability: 97.7% sensitivity and 96% specificity.	[40]
	rRT-PCR	Sample: Nasopharyngeal swab, oropharyngeal swab, sputum, and/or bronchoalveolar lavage.	[37]
Bhutan	RDT	Sample: Blood Result: 30 minutes Reliability: 70% sensitivity and 90% specificity.	[41]
	rRT- PCR	Sample: Nasopharyngeal swab, oropharyngeal swab, sputum, and/or bronchoalveolar lavage.	[37]
	TrueNAT	2-step process, Step 1: E gene screening assay Step 2: RdRp gene confirmatory assay Result: 30−60 minutes Reliability 100%.	[42,43]
	CBNAAT	2-step process, Step 1: E gene screening assay Step 2: SARS-CoV-2 specific N2 region of the N gene. Result: 30−60 minutes Reliability: 100%.	[42,43]
	RAT	Sample: Nasopharyngeal swab. Result: within 30 minutes. Reliability: 50.6%−84% sensitivity and 99.3−100% specificity.	[44]
India	COVID ELISA (IgG ELISA test)	Sample: Blood serum or plasma. Reliability: 92.4% sensitivity and 97.9% specificity.	[45]
	Feluda-CRISPR Test	Sample: Nasal or throat swab. Result: within 1hour Reliability: 100% sensitivity and 97% specificity.	[46]
	rRT-PCR	Sample: Nasopharyngeal swab, oropharyngeal swab, sputum, and/or bronchoalveolar lavage.	[37]
Maldives	GeneXpert cartridges	Sample: Swab sample. Identification of E gene and N2 region of the N gene of SARS-CoV-2	[47]
	RAT (BinaxNOW COVID-19 Ag Card)	Reliability: 97% sensitivity, 98.5% specificity.	[48]
	rRT-PCR	Sample: Nasopharyngeal swab, oropharyngeal swab, sputum, and/or bronchoalveolar lavage.	[37]
Nepal	RDT	Sample: Blood. Reliability: 50% sensitivity, 99.5% specificity.	[49]
	rRT-PCR	Sample: Nasopharyngeal swab, oropharyngeal swab, sputum and/or bronchoalveolar lavage.	[37]
Pakistan	Antigen detection Rapid Diagnostic Tests (Ag-RDT)	Sample: nasopharyngeal swab (NSP) and saliva 52% sensitivities for NSP-RDT 21% sensitivities for Saliva-RDT.	[50]
Sri Lanka	rRT-PCR	Sample: Nasopharyngeal swab, oropharyngeal swab, sputum, and/or bronchoalveolar lavage.	[37]

In Bangladesh, physicians prescribed dexamethasone and antiviral drugs such as remdesivir or favipiravir for critical patients [53,54]. A local pharmaceutical company introduced the world's first generic remdesivir [55]. Convalescent plasma therapy (CP) had a beneficial impact on patients in Bangladesh, especially in critical cases when plasma therapy was the only option. The government established a plasma network "Shohojoddha'' to expedite the availability [40].

The government of Bhutan provided free testing amenities, which resulted in timely diagnosis and treatment. Bhutan was praised by the WHO for its prompt intervention. Patients having mild

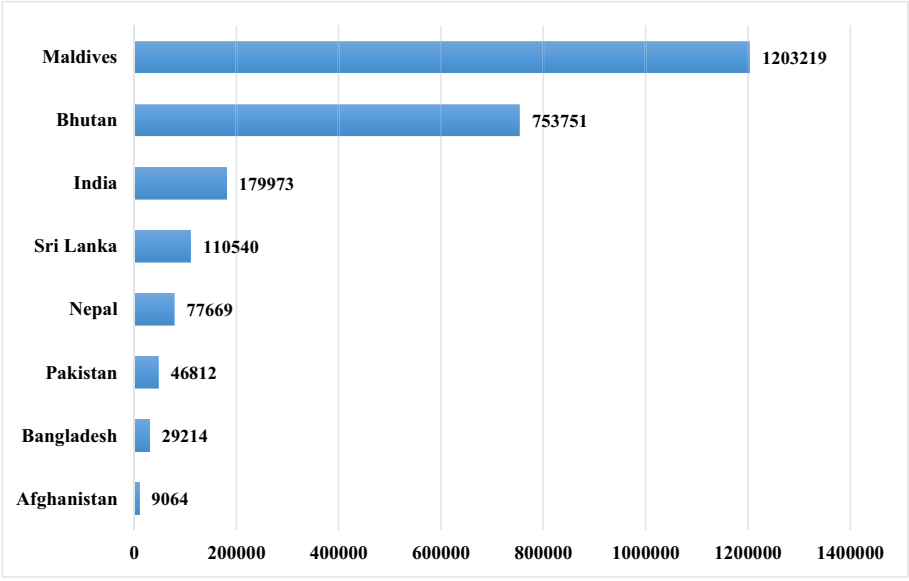

Fig. 4. COVID-19 tests per million population in South Asian countries.

symptoms with risk factors of pneumonia and other symptoms were treated with hydroxychloroquine with or without Lopinavir/Ritonavir [56]. Additional therapies such as low molecular weight heparin, steroids, and antibiotics were also being used based on disease severity [57].

India, one of the most affected countries, is facing a critical situation and is looking for effective treatment methods. Hydroxychloroquine was recommended for mild cases, whereas a combination of the drug and azithromycin was prescribed for severe patients [58]. The central government authorized the use of two antiviral drugs, remdesivir, and favipiravir but there has always been a debate among the medical experts about their competency in treating COVID-19 patients [59]. They approved an anti-CD6 monoclonal antibody, itolizumab, for moderate and severe patients [60]. CP therapy or immune plasma therapy emerged as a hope for critical patients. The Indian Council of Medical Research commenced clinical trials to evaluate its potential use and side effects, albeit the therapy was already being used. This treatment served as a short-term solution to reduce the fatality rate [61].

The Maldives published COVID-19 Guidelines that recommended empirical antibiotics along with oseltamivir based on clinical diagnosis [62]. Their health system depends largely on non-native medical professionals, constituting 66% of doctors and 44% of nurses of total healthcare providers [63]. Also being a country with many islands, decentralization of the health facilities was quite difficult.

Health experts in Nepal recommended antipyretics for mild patients. Antiviral drugs remdesivir and favipiravir were prescribed for severe cases, whereas chloroquine or hydroxychloroquine were discouraged [64]. Ayurveda and traditional medicines have been approved as a management option in the country because these proved to be immune boosters. However, more evidence is needed regarding its efficacy [65]. They categorized COVID-19 dedicated hospitals into three levels: Level-1 for mild patients, Level-2 for moderate patients, and Level-3 for critical patients who needed specialized treatment, such as ventilators or ICU [66].

In Pakistan, dexamethasone was being used to treat critical COVID-19 in patients. The WHO addressed it as a "lifesaving breakthrough" because it showed a decreased fatality rate among critical COVID-19 patients [67]. Another immune-suppressive drug, actemra, was used for critical SARS-CoV-2 patients. The interleukin-6 (IL-6) inhibitor was prescribed to patients with an abnormal level of IL-6 leading to respiratory distress [68].

The Sri Lankan Guidelines on COVID-19 recommended antipyretics for mild patients [69]. Sri Lanka is a country that promotes Ayurvedic and herbal medicine to fight COVID-19. Herbal therapy has been introduced under government supervision. An immunizing drink named "Suwadharani Immunizing Drink" and a powder named "Sadanga Panaya" have been developed for individuals infected with SARS-CoV-2 [70,71].

3.5. Preventive schemes

Amid the restoration process in war-torn Afghanistan, the Afghan government tried to take containment measures, including decreasing border entry activity and arranging quarantine services for infected people [72]. They announced a budget of around 8 billion Afghanis for COVID-19-related expenditures, including 1.9 billion Afghanis as an immediate health necessity to mitigate the economic blows [73]. The government and the United Nations (UN) have developed schemes for mass vaccination programs with vaccines free of cost through the COVAX Advanced Market Commitment facility and received the first shipment of Covishield on 8 March 2021 [74].

In Bangladesh, after confirming their first three cases, the government declared general holidays and ordered a countrywide lockdown. They opened telemedicine services and promulgated an obligatory quarantine of foreign returnees [75]. The country was divided into three zones according to the disease prevalence and implemented lockdown measures accordingly [76]. Furthermore, the government provided 19 stimulus packages worth over 12.13 billion USD to support various sectors in combating COVID-19 [40]. On 7 February 2021, a nationwide vaccination began with the administration of 2 million doses of the Covishield vaccine from India. Moreover, the government will receive 12.79 million doses of the Oxford University-AstraZeneca vaccine through the COVAX initiative [77,78]. Bangladesh is also attempting to develop a vaccine named "Bongovax." It is being developed by a local pharmaceutical firm, Globe Biotech, and waiting for approval to conduct clinical trials [79].

Bhutan put great emphasis on preventing community transmission and initiated early measures, such as an immediate national lockdown and contact tracing. They encouraged people to get testing with free tests and to quarantine after exposure [80]. The government worked closely with the WHO to provide the latest technical guidelines and strategies, which have facilitated the timely response to tackle COVID-19 in the country [81].

After detecting its first case, the government of India minimized mobility by declaring the "Janata Curfew," which strictly maintained lockdown and social distancing throughout the country [82]. They set up 2 million retail shops called "Suraksha Stores" to ensure everyday commodities to citizens while maintaining safety practices [83]. A response team was appointed to locate all possible contacts and demarcate the containment and safe zone according to the prevalence of infection [82]. Also, they launched mobile apps such as "Aarogya Setu" and "My Gov Corona Helpdesk" to disseminate information and ensure contact tracing [84]. The government granted several relief packages worth about INR 29.7 trillion; INR 12.71 trillion were monetary incentives and INR 17.16 trillion were allocated to accelerate the economy and reduce the repercussions of COVID-19 [85]. Recently, the country has launched the world's biggest vaccination program by approving two vaccines: the Oxford/AstraZeneca vaccine, locally known as Covishield, and India-based Bharat Biotech's Covaxin [79].

The Maldives was divided into six zones to monitor the zones individually for engagement, preparedness, and response. Remote resorts were turned into quarantine centers [86]. In addition to these, the government has developed schemes including establishing effective patient flow, utilizing web-based digital health tools, and financing the healthcare workforce to reduce the ramifications of COVID-19 [87]. An economic relief package of 67.1 million USD was allocated to assist households and businesses [88].

Nepal has taken timely interventions such as limiting regular mobility, accelerating testing, as well as implementing social distancing and contact tracing. COVID-19−dedicated hospitals were equipped with increased amenities [89,90]. The federal government, in coordination with local and provincial governments, has put in a great effort to ensure the necessary logistical support and to raise public awareness [89]. The country received 1 million doses of the Covishield vaccine from India and inaugurated its vaccination drive on 27 January 2021 [77].

Following the detection of its first positive case, the Pakistani government activated the Emergency Operation Centre that conducted training on surveillance and strengthened the existing healthcare facilities. International flights were suspended and borders were shut. Educational institutions, shopping malls, and public gatherings were closed down. Pakistan adopted "smart lockdown strategies" instead of a countrywide lockdown by recognizing high-risk areas and hotspots [91]. The government budgeted an incentive package of 8 billion USD to assist businesses and the emergency response and to provide relief to residents [92]. They granted authorization for two vaccines: the Oxford-AstraZeneca vaccine and the Sinopharm vaccine

from China. Pakistan received 1,238,400 doses of AstraZeneca's vaccines through COVAX on 8 May 2021 [93].

Sri Lanka introduced a range of preventive measures including travel restrictions, isolation of villages, and closure of airports to inbound passengers [94,95]. All the SARS-CoV-2 positive patients were treated (regardless of the severity of the disease) in the state COVID-19 dedicated hospitals. The hospitals were facilitated with ICUs and ventilators for critically ill patients. The country launched its vaccination program on 29 January 2021 with the administration of the Covishield vaccine. Over 118,767 health workers got vaccinated as of 31 January 2021 [96].

Vaccination is considered the only means of preventing the disease. All the South Asian countries have started vaccination drives. India appeared to be in the top position regarding access to vaccine doses. However, only 5.7% of India's population was fully vaccinated, whereas the Maldives has vaccinated over 65% of its population as of 16 July 2021 (Table 1) [35].

4. Discussion

Genome analysis of SARS-CoV-2 suggests that despite some similarities, numerous distinct mutations were observed in genomes of various isolates from the SAC. The most frequent mutations were mostly insertions and/or deletions. Mutations in ORF1ab, ORF1a, and ORF3 were predominant. Moreover, SNPs were common, albeit alterations in the levels of the amino acid significantly vary in the genomes. These unique and novel mutations have made the virus more infectious than any other coronaviruses. As a consequence, a preponderance of the population is being infected despite taking precautionary measures. The sudden appearance of the delta variant (B.1.617.2), which originated from India, has led to surging infection rates in neighboring countries. All the SAC except Pakistan has recorded their highest number of COVID-19 cases after the delta variant spread to these countries. It was obvious that delta was more infectious than previous variants [97,98]. Therefore, early and rapid genome sequence-based surveillance and laboratory studies are needed to facilitate a "one-size-fits-all" vaccine development strategy against the virus.

A majority of the countries in this region have had difficulties tackling this disease due to under-resourced healthcare facilities and a shortage of healthcare professionals. They cannot meet the recommended standards of 10 physicians and 44.5 health care professionals (doctors, nurses, and midwives) per 10,000 people [99,100]. For example, according to the World Health Statistics, Afghanistan which has only 2.8 physicians per 10,000 people and 4.5 nurses and midwives per 10,000 people was greatly striving to attain the required number of professionals. Bangladesh, Bhutan, and India have a shortage of the required number of health care professionals as well. Despite having the requisite number of doctors, the Maldives, Pakistan, and Sri Lanka lack the cumulative required number of health professionals (Table 3) [101]. Many of them are not well-trained enough to handle an infectious disease outbreak. This situation has significantly impacted the overall management system and is reflected by the high number of COVID-19 patients in several countries.

Afghanistan, Bangladesh, and India are facing serious repercussions of COVID-19. It is very challenging for war-ravaged Afghanistan to provide necessary amenities for its health care system, let alone develop a surveillance system for a pandemic. The country depends on foreign assistance and on various international organizations such as the WHO and the United Nations collaborating with the government to continuously provide aid for health and the economy. There have not been enough resources to restore health infrastructure and services after the war's havoc. This situation has made it quite impossible for Afghanistan to effectively combat the pandemic, which is reflected by its high fatality rate and low recovery rate. Bangladesh, one of the most densely populated countries in South Asia, could not impose strict mobility restrictions because nearly one-fifth of the population lives below the poverty line [102]. Therefore, a relaxed lockdown strategy was adopted, which has resulted in several COVID-19 waves. In addition to these, Bangladesh is highly dependent on foreign export and import and could not prohibit transboundary movements [103]. Moreover, the newly emerged delta variant contributed to the rise of COVID-19 cases in the country. The Indian government's improvident policies of relaxed movement

Table 3. The density of healthcare providers per 10,000 population in South Asian countries.

Country	Physicians	Nurses and midwives
Afghanistan	2.8	4.5
Bangladesh	6.4	3.9
Bhutan	4.6	18.3
India	9.3	23.9
Maldives	17.1	64.3
Nepal	8.1	33.0
Pakistan	11.2	4.8
Sri Lanka	11.5	22.6

restrictions have been criticized by health experts. They allowed people to celebrate festivals, such as 'Holi' and the 'Kumbh Mela,' where thousands of individuals gathered without maintaining social distance and preventive practices. A famous cricket tournament was held with spectators crowded in a closed environment. Moreover, a large number of political supporters attended election rallies [104,105]. All of these imprudent actions, along with the highly infectious delta variant, contributed significantly to the surge in the infection rate in the country.

Only proper testing, tracing, and treatment can minimize the loss due to this virus. Still, a scarcity of testing and treatment amenities exists in most of the SAC. The need for digital health strategies has been visible more than ever. All the countries have prioritized their digital health care including providing telemedicine and developing apps dedicated to COVID-19-related information. Vaccination has been started in most countries. Yet controversy and distrust persist because of early vaccine discovery. Covaxin from India has been granted emergency use authorization. Authorities of the SAC are working with various national and international collaborators to ensure the distribution of vaccines. The UN, the Global Alliance for Vaccines and Immunization (GAVI), and the WHO are trying to ensure vaccines are distributed in the lower and lower-middle-income countries through COVAX facilities. Policymakers and public health experts play significant roles in popularizing rapid and mass vaccination programs in the region. Vaccines against the virus are the only hope to combat this novel disease. Still, rapid and unpredictable mutation and transmission have made it very difficult to combat the pandemic. Hence, preventive measures and disease surveillance are key strategies to tackle this pandemic. Smart and balanced lockdown policies that sustain both economy and health should be adopted. International and regional cooperation among the neighboring countries is mandatory to combat the pandemic. Policymakers, government officials, and experts in various fields should come forward to work hand in hand to establish sophisticated response operations for future outbreaks.

5. Conclusion

COVID-19 is a matter of global concern. It has challenged every sector, from health to economy and society. The under-resourced South Asian countries have faced the devastating effects of COVID-19. They have utilized national and regional cooperation to mitigate its consequences. But the shortage of healthcare facilities, impoverished public health infrastructures, and imprudent decisions of policymakers have made it quite tough to handle the outbreak. Also, because of the novel characteristics of the virus, it has been difficult to implement any systematic strategies to suppress it. This pandemic has created an opportunity to rethink the public health infrastructures of every country. If utilized properly, it will be possible to develop strategies to prevent future zoonotic outbreaks in this region.

Funding

No funding was received for this study.

Conflict of interest

None.

References

[1] Ge H, Wang X, Yuan X, Xiao G, Wang C, Deng T, et al. The epidemiology and clinical information about COVID-19. Eur J Clin Microbiol Infect Dis 2020;39(6):1011–9. https://doi.org/10.1007/s10096-020-03874-z.

[2] Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, et al. Clinical characteristics of coronavirus disease 2019 in China. N Engl J Med 2020;382(18):1708–20. https://doi.org/10.1056/NEJMoa2002032.

[3] Wu A, Peng Y, Huang B, Ding X, Wang X, Niu P, et al. Genome composition and divergence of the novel coronavirus (2019-nCoV) originating in China. Cell Host Microbe 2020;27(3):325–8. https://doi.org/10.1016/j.chom.2020.02.001.

[4] Chen Y, Liu Q, Guo D. Emerging coronaviruses: genome structure, replication, and pathogenesis. J Med Virol 2020;92(4):418–23. https://doi.org/10.1002/jmv.25681.

[5] Koyama T, Platt D, Parida L. Variant analysis of SARS-CoV-2 genomes. Bull World Health Organ 2020;98(7):495–504. https://doi.org/10.2471/blt.20.253591.

[6] Lauring AS, Hodcroft EB. Genetic variants of SARS-CoV-2-what do they mean? JAMA 2021;325(6):529–31. https://doi.org/10.1001/jama.2020.27124.

[7] World Health Organization [WHO]. Tracking SARS-CoV-2 variants [cited 2021 Jul 7]. Available from: https://www.who.int/en/activities/tracking-SARS-CoV-2-variants/.

[8] World Health Organization [WHO]. WHO coronavirus (Covid-19) dashboard [cited 2021 Jul 16]. Available from: https://covid19.who.int/.

[9] SAARC Disaster Management Centre. Situation report - SAARC region: covid-19 [cited 2021 Jul 18]. Available from: http://www.covid19-sdmc.org/situation-report.

[10] Pruthi G, Parkash H, Bharathi PV, Jain R, Gupta A, Rai S. Comprehensive review of guidelines to practice prosthodontics and implant procedures during COVID-19 pandemic. J Oral Biol Craniofac Res 2020;10(4):768–75. https://doi.org/10.1016/j.jobcr.2020.10.010.

[11] National Center for Biotechnology Information. NCBI virus [cited 2021 Jun 4]. Available from: https://www.ncbi.nlm.nih.gov/labs/virus/vssi/#/virus?SeqType_s=Nucleotide&VirusLineage_ss=Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), taxid:2697049&CreateDate_dt=2019-12-31T00:00:00.00Z TO 2021-03-31T23:59:59.00Z&Country_s=Bangladesh&Cou.

[12] Mohmmad Mahmud AS, Taznin T, Hasan Sarkar MM, Uzzaman MS, Osman E, Habib MA, et al. The genetic variant analyses of SARS-CoV-2 strains; circulating in Bangladesh. bioRxiv 2020. https://doi.org/10.1101/2020.07.29.226555 [Preprint].
[13] Hasan MM, Das R, Rasheduzzaman M, Hussain MH, Muzahid NH, Salauddin A, et al. Global and local mutations in Bangladeshi SARS-CoV-2 genomes. Virus Res 2021; 297:198390. https://doi.org/10.1016/j.virusres.2021.198390.
[14] Saha I, Ghosh N, Maity D, Sharma N, Sarkar JP, Mitra K. Genome-wide analysis of Indian SARS-CoV-2 genomes for the identification of genetic mutation and SNP. Infect Genet Evol 2020;85:104457. https://doi.org/10.1016/j.meegid.2020.104457.
[15] Raghav S, Ghosh A, Turuk J, Kumar S, Jha A, Madhulika S, et al. Analysis of Indian SARS-CoV-2 genomes reveals prevalence of D614G mutation in Spike protein predicting an increase in interaction with TMPRSS2 and virus infectivity. Front Microbiol 2020;11:594928. https://doi.org/10.3389/fmicb.2020.594928.
[16] Muttineni R, Kammili N, Bingi TC, Rao MR, Putty K, Dholaniya PS, et al. Clinical and whole genome characterization of SARS-CoV-2 in India. PLoS One 2021;16(2): e0246173. https://doi.org/10.1371/journal.pone.0246173.
[17] Sah R, Rodriguez-Morales AJ, Jha R, Chu DKW, Gu H, Peiris M, et al. Complete genome sequence of a 2019 novel coronavirus (SARS-CoV-2) strain isolated in Nepal. Microbiol Res Announc 2020;9(11). https://doi.org/10.1128/mra.00169-20.
[18] Ghanchi NK, Masood KI, Nasir A, Khan W, Abidi SH, Shahid S, et al. SARS-CoV-2 genome analysis of strains in Pakistan reveals GH, S and L clade strains at the start of the pandemic. bioRxiv 2020. https://doi.org/10.1101/2020.08.04.234153 [Preprint].
[19] Saif R, Mahmood T, Ejaz A, Zia S, Qureshi AR. Whole genome comparison of Pakistani Corona virus with Chinese and US strains along with its predictive severity of COVID-19. Gene Rep 2021;23:101139. https://doi.org/10.1016/j.genrep.2021.101139.
[20] Satharasinghe DA, Parakatawella P, Premarathne J, Jayasooriya L, Prathapasinghe GA, Yeap SK. Evolutionary and genomic analysis of four SARS-CoV-2 isolates circulating in March 2020 in Sri Lanka; additional evidence on multiple introduction and further transmission. Epidemiol Infect 2021; 149:e78. https://doi.org/10.1017/S0950268821000583.
[21] Afghanistan, Ministry of Public Health. MOPH-Covid-19 dashboard [cited 2021 Feb 9]. Available from: http://covid.moph-dw.org/#/.
[22] World Health Organization [WHO]. Coronavirus disease (COVID-2019) Bangladesh situation report [cited 2021 Feb 9]. Available from: https://www.who.int/bangladesh/emergencies/coronavirus-disease-(covid-19)-update/coronavirus-disease-(covid-2019)-bangladesh-situation-reports.
[23] National Centre for Disease Control [NCDC]. Dashboard [cited 2021 Feb 9]. Available from: https://ncdc.gov.in/dashboard.php.
[24] Maldives, Ministry of Health. COVID-19 dashboard [cited 2021 Feb 9]. Available from: https://covid19.health.gov.mv/dashboard/?c=0.
[25] Nepal, Ministry of Health and Population. Covid19-dashboard [cited 2021 Feb 9]. Available from: https://covid19.mohp.gov.np/.
[26] Pakistan Institute of Development Economics. Pakistan-coronavirus live update [cited 2021 Feb 9]. Available from: https://datastudio.google.com/embed/reporting/4f8d15d3-751a-44ef-a5f7-f5f171cb570d/page/yVNJB.
[27] Covid-19 dashboard Sri Lanka [cited 2021 Feb 9]. Available from: http://covid19sl.com/?fbclid=IwAR0p28pI7xbOCR_GK8IL6hLzGc3NTqNdjMU2u5MTf5frCIvti8-v5sqxiu4.
[28] Anca PS, Toth PP, Kempler P, Rizzo M. Gender differences in the battle against COVID-19: impact of genetics, comorbidities, inflammation and lifestyle on differences in outcomes. Int J Clin Pract 2021;75(2):e13666. https://doi.org/10.1111/ijcp.13666.
[29] Chen L, Li X, Chen M, Feng Y, Xiong C. The ACE2 expression in human heart indicates new potential mechanism of heart injury among patients infected with SARS-CoV-2. Cardiovasc Res 2020;116(6):1097−100. https://doi.org/10.1093/cvr/cvaa078.
[30] Bwire GM. Coronavirus: why men are more vulnerable to Covid-19 than women? SN Compr Clin Med 2020:1−3. https://doi.org/10.1007/s42399-020-00341-w.
[31] Sarria-Guzman Y, Fusaro C, Bernal JE, Mosso-Gonzalez C, Gonzalez-Jimenez FE, Serrano-Silva N. Knowledge, attitude and practices (KAP) towards COVID-19 pandemic in America: a preliminary systematic review. J Infect Dev Ctries 2021;15(1):9−21. https://doi.org/10.3855/jidc.14388.
[32] Machado BAS, Hodel KVS, Barbosa-Junior VG, Soares MBP, Badaro R. The main molecular and serological methods for diagnosing COVID-19: an overview based on the literature. Viruses 2020;13(1). https://doi.org/10.3390/v13010040.
[33] World Health Organization [WHO]. Technical guidance publications - coronavirus disease (COVID-19) [cited 2020 Oct 13]. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance-publications.
[34] Corman VM, Landt O, Kaiser M, Molenkamp R, Meijer A, Chu DK, et al. Detection of 2019 novel coronavirus (2019-nCoV) by real-time RT-PCR. Euro Surveill 2020;25(3). https://doi.org/10.2807/1560-7917.Es.2020.25.3.2000045.
[35] Bloomberg. More than 3.54 billion shots given: covid-19 vaccine tracker [cited 2021 Jul 16]. Available from: https://www.bloomberg.com/graphics/covid-vaccine-tracker-global-distribution/#global.
[36] Worldometer. Coronavirus update [cited 2021 Apr 6]. Available from: https://www.worldometers.info/coronavirus/.
[37] World Health Organization [WHO]. Laboratory testing for 2019 novel coronavirus (2019-nCoV) in suspected human cases [cited 2021 Apr 16]. Available from: https://www.who.int/publications/i/item/10665-331501.
[38] Rakotosamimanana N, Randrianirina F, Randremanana R, Raherison MS, Rasolofo V, Solofomalala GD, et al. GeneXpert for the diagnosis of COVID-19 in LMICs. Lancet Glob Health 2020;8(12):e1457−8. https://doi.org/10.1016/s2214-109x(20)30428-9.
[39] World Health Organization [WHO]. Get tested! WHO supports the Government of Bangladesh in establishing a broad testing lab network throughout the country [cited 2021 May 17]. Available from: https://www.who.int/bangladesh/news/detail/30-03-2021-get-tested!-who-supports-the-government-of-bangladesh-in-establishing-a-broad-testing-lab-network-throughout-the-country.
[40] Al Noman A, Islam MS, Sana S, Mondal P, Meem RI, Rana S, et al. A review of the genome, epidemiology, clinical features, prevention, and treatment scenario of COVID-19: Bangladesh aspects. Egypt J Bronchol 2021;15(1):8. https://doi.org/10.1186/s43168-021-00053-2.
[41] Lamsang T. MoH running 10,000 plus COVID-19 tests along Southern border, Thimphu and Paro to check for community transmission [updated 2020 Apr 8; cited 2020 Oct 18]. Available from: https://thebhutanese.bt/moh-running-10000-plus-covid-19-tests-along-southern-border-thimphu-and-paro-to-check-for-community-transmission/.
[42] Ghoshal U, Vasanth S, Tejan N. A guide to laboratory diagnosis of Corona Virus Disease-19 for the gastroenterologists. Indian J Gastroenterol 2020;39(3):236−42. https://doi.org/10.1007/s12664-020-01082-3.
[43] Indian Council of Medical Research. Advisory: newer additional strategies for Covid-19 testing existing strategies for Covid-19 testing [cited 2021 Mar 15]. Available from: https://www.icmr.gov.in/pdf/covid/strategy/Advisory_for_rapid_antigen_test_14062020.pdf.
[44] Indian Council of Medical Research. Advisory on use of rapid antigen detection test for Covid-19 [cited 2021 Mar

12]. Available from: https://www.icmr.gov.in/pdf/covid/strategy/Advisory_for_rapid_antigen_test14062020.pdf.
[45] Sapkal G, Shete-Aich A, Jain R, Yadav PD, Sarkale P, Lakra R, et al. Development of indigenous IgG ELISA for the detection of anti-SARS-CoV-2 IgG. Indian J Med Res 2020;151(5):444−9. https://doi.org/10.4103/ijmr.IJMR_2232_20.
[46] Azhar M, Phutela R, Kumar M, Ansari AH, Rauthan R, Gulati S, et al. Rapid, accurate, nucleobase detection using FnCas9. medRxiv 2020. https://doi.org/10.1101/2020.09.13.20193581 [Preprint].
[47] World Health Organization [WHO]. Maldives response to Covid-19. Sitrep: 9 July, 2020. [cited 2021 Mar 11]. Available from: https://www.who.int/docs/default-source/maldives/maldives-sitrep-9-july2020.pdf?sfvrsn=6e6e278e_2.
[48] Mohamed S. Medtech brings rapid-result COVID-19 test kits to Maldives [updated 2020 Sep 28; cited 2020 Oct 20]. Available from: https://edition.mv/news/19427.
[49] Poudel A. Rapid test kits procured by Omni only accurate 50 percent of the time, says report [updated 2020 Jun 18; cited 2020 Oct 19]. Available from: https://kathmandupost.com/health/2020/06/18/rapid-test-kits-procured-by-omni-only-accurate-50-percent-of-the-time-says-report.
[50] Saeed U, Uppal SR, Piracha ZZ, Rasheed A, Aftab Z, Zaheer H, et al. Evaluation of SARS-CoV-2 antigen-based rapid diagnostic kits in Pakistan: formulation of COVID-19 national testing strategy. Virol J 2021;18(1):34. https://doi.org/10.1186/s12985-021-01505-3.
[51] Sarwar S, Parsa N, Siddique A. Afghan Gov't warns against popular but unproven coronavirus treatment [updated 2020 Jun 1; cited 2020 Oct 12]. Available from: https://gandhara.rferl.org/a/afghan-gov-t-warns-against-popular-but-unproven-coronavirus-treatment/30646578.html.
[52] Nemat A, Asady A, Raufi N, Zaki N, Ehsan E, Noor NAS, et al. A survey of the healthcare workers in Afghanistan during the COVID-19 pandemic. Am J Trop Med Hyg 2021;104(2):537−9. https://doi.org/10.4269/ajtmh.20-1367.
[53] Hossain A, Raknuzzaman M, Tokumura M. Coronavirus (COVID-19) pandemic: concern about misuse of antibiotics. J Biomed Anal 2020;3(2):19−23. https://doi.org/10.30577/jba.v3i2.44.
[54] Mah EMS, Hassan MZ, Biswas M, Rahman F, Akhtar Z, Das P, et al. Use of antimicrobials among suspected COVID-19 patients at selected hospitals, Bangladesh: findings from the first wave of COVID-19 pandemic. Antibiotics 2021;10(6). https://doi.org/10.3390/antibiotics10060738.
[55] Mohiuddin AK. A pandemic review of COVID-19 situation in Bangladesh. J Biosci Biomed Eng 2020;1(1):1−9.
[56] LeVine S, Dhakal GP, Penjor T, Chuki P, Namgyal K, Tshokey, et al. Case report: the first case of COVID-19 in Bhutan. Am J Trop Med Hyg 2020;102(6):1205−7. https://doi.org/10.4269/ajtmh.20-0259.
[57] Tshokey T. An update on COVID-19 in Bhutan. Bhutan Health J 2020;6(1):3. https://doi.org/10.47811/bhj.91.
[58] Sharma S, Basu S, Shetti NP, Aminabhavi TM. Current treatment protocol for COVID-19 in India. Sensors Int 2020;1:100013. https://doi.org/10.1016/j.sintl.2020.100013.
[59] Vaidyanathan G. Scientists criticize use of unproven COVID drugs in India. Nature 2020;587(7833):187−8. https://doi.org/10.1038/d41586-020-03105-7.
[60] Atal S, Fatima Z, Balakrishnan S. Approval of itolizumab for COVID-19: a premature decision or need of the hour? BioDrugs 2020;34(6):705−11. https://doi.org/10.1007/s40259-020-00448-5.
[61] Teixeira da Silva JA. Convalescent plasma: a possible treatment of COVID-19 in India. Med J Armed Forces India 2020;76(2):236−7. https://doi.org/10.1016/j.mjafi.2020.04.006.
[62] Shohan MUS, Alam ASMRU, Rakhi NN, Kabir M, Siam MKS, Hasan MM, et al. Onset, transmission, impact, and management of COVID-19 epidemic at early stage in SAARC countries. Authorea 2020. https://doi.org/10.22541/au.159775079.90952648 [Preprint].
[63] Usman SK, Moosa S, Abdullah AS. Navigating the health system in responding to health workforce challenges of the COVID-19 pandemic: the case of Maldives (short case). Int J Health Plann Manag 2021;36(S1):182−9. https://doi.org/10.1002/hpm.3136.
[64] Nepal Medical Council. Interim clinical guidance for care of patients with Covid-19 in healthcare settings [cited 2021 Mar 2]. Available from: https://nmc.org.np/interim-clinical-guidance-for-care-of-patients-with-covid-19-in-healthcare-settings.
[65] Pandit RD, Singh RK. COVID-19 Ayurveda treatment protocol of governments of Nepal and India: a review and perspective. Appl Sci Technol Ann 2020;1(1):72−80. https://doi.org/10.3126/asta.v1i1.30276.
[66] Rayamajhee B, Pokhrel A, Syangtan G, Khadka S, Lama B, Rawal LB, et al. How well the government of Nepal is responding to COVID-19? An experience from a resource-limited country to confront unprecedented pandemic. Front Public Health 2021;9:597808. https://doi.org/10.3389/fpubh.2021.597808.
[67] Fatima SA, Asif M, Khan KA, Siddique N, Khan AZ. Comparison of efficacy of dexamethasone and methyl-prednisolone in moderate to severe covid 19 disease. Ann Med Surg (Lond) 2020;60:413−6. https://doi.org/10.1016/j.amsu.2020.11.027.
[68] Zain Mushtaq M, Zafar Mahmood Bin, Jamil B, Aziz A, Ali SA. Outcome of COVID-19 patients with use of Tocilizumab: a single center experience. Int Immunopharm 2020;88:106926. https://doi.org/10.1016/j.intimp.2020.106926.
[69] Sri Lanka, Ministry of Health, Epidemiology Unit. Provisional clinical practice guidelines on COVID-19 suspected and confirmed patients [cited 2021 Feb 13]. Available from: https://epid.gov.lk/web/images/pdf/Circulars/Corona_virus/covid-19_cpg_version_5.pdf.
[70] Sri Lanka to introduce herbal medicine to control and cure Covid-19 patients [updated 2020 Oct 11; cited 2021 Jan 13]. Available from: https://www.lankanewsweb.net/67-general-news/70046-Sri-Lanka-to-introduce-herbal-medicine-to-control-and-cure-Covid-19-patients.
[71] Udayanga S, Ekanayake P. Witnessing a going back to authentic medical heritage in Sri Lanka: an anthropological study on covid-19 experiences and use of alternative health care approaches [cited 2021 Jan 13]. Available from: https://www.researchgate.net/publication/345598258_Witnessing_a_Going_Back_to_Authentic_Medical_Heritage_in_Sri_Lanka_An_Anthropological_Study_on_Covid-19_Experiences_and_the_Use_of_Alternative_Health_Care_Approaches.
[72] Mousavi SH, Abdi M, Zahid SU, Wardak K. Coronavirus disease 2019 (COVID-19) outbreak in Afghanistan: measures and challenges. Infect Control Hosp Epidemiol 2021;42(3):366−7. https://doi.org/10.1017/ice.2020.240.
[73] Basij-Rasikh S, Khalil M, Safi N. Early responses to COVID-19 in Afghanistan. East Mediterr Health J 2020;26(12):1442−5. https://doi.org/10.26719/emhj.20.137.
[74] WHO Eastern Mediterranean Region. COVID-19 vaccines shipped by COVAX arrive in Afghanistan [cited 2021 Mar 14]. Available from: http://www.emro.who.int/afg/afghanistan-news/covid-19-vaccines-shipped-by-covax-arrive-in-afghanistan.html.
[75] Rahman SMM, Hossain SM, Jahan MU. Digital health during COVID-19 pandemic and beyond. Bangladesh Med Res Counc Bull 2020;46:66−7. https://doi.org/10.3329/bmrcb.v46i2.49014.
[76] Hossain MA, Jahid MIK, Hossain KMA, Walton LM, Uddin Z, Haque MO, et al. Knowledge, attitudes, and fear of COVID-19 during the rapid rise period in Bangladesh. PLoS One 2020;15(9):e0239646. https://doi.org/10.1371/journal.pone.0239646.
[77] WHO South-East Asia Regional Office. COVID-19 weekly situation report: week 3 [cited 2021 Mar 10]. Available from: https://cdn.who.int/media/docs/default-source/searo/whe/coronavirus19/sear-weekly-reports/searo-weekly-situation-report-3_2021.pdf?sfvrsn=651b3dbc_9.

[78] WHO South-East Asia Regional Office. COVID-19 weekly situation report: week 5 [cited 2021 Mar 14]. Available from: https://cdn.who.int/media/docs/default-source/searo/whe/coronavirus19/sear-weekly-reports/searo-weekly-situation-report-5.pdf?sfvrsn=ad5917ef_4.
[79] WHO South-East Asia Regional Office. COVID-19 weekly situation report: week 2 [cited 2021 Mar 10]. Available from: https://www.who.int/docs/default-source/searo/whe/coronavirus19/sear-weekly-reports/searo-weekly-situation-report-2_2021.pdf.
[80] Tsheten T, Wangchuk S, Wangmo D, Clements ACA, Gray DJ, Wangdi K. COVID-19 response and lessons learned on dengue control in Bhutan. J Med Entomol 2021; 58(2):502−4. https://doi.org/10.1093/jme/tjaa225.
[81] Gyem K, Monger A, Darnal JB, Adhikari LM, Wangchuk S, Dorji T. A descriptive study of confirmed COVID-19 cases in Bhutan. J Infect Dis Epidemiol 2020;6(4):142. https://doi.org/10.23937/2474-3658/1510142.
[82] Venkata-Subramani M, Roman J. The coronavirus response in India - world's largest lockdown. Am J Med Sci 2020; 360(6):742−8. https://doi.org/10.1016/j.amjms.2020.08.002.
[83] Suvarnakhandi S, Das S. Economic impact of the Covid-19 pandemic in India [cited 2021 Jan 11]. Available from: http://shabdbooks.com/gallery/162-june2020.pdf.
[84] Davalbhakta S, Advani S, Kumar S, Agarwal V, Bhoyar S, Fedirko E, et al. A systematic review of smartphone applications available for corona virus disease 2019 (COVID19) and the assessment of their quality using the mobile application rating scale (MARS). J Med Syst 2020;44(9):164. https://doi.org/10.1007/s10916-020-01633-3.
[85] Chakrabarty HS, Ray P, Pal P. The Covid-19 pandemic and economic stimulus in India: has it been a hostage of macroeconomic complications? Int Rev Appl Econ 2021:1−17. https://doi.org/10.1080/02692171.2021.1905786.
[86] World Health Organization [WHO]. Health system response to COVID-19: republic of Maldives [cited 2020 Dec 9]. Available from: https://www.who.int/docs/default-source/maldives/hs-response-to-covid19-in-maldives-wco-june-2020.pdf?sfvrsn=eb72612a_2.
[87] Suzana M, Moosa S, Rafeeg FN, Usman SK. Early measures for prevention and containment of COVID-19 in the Maldives: a descriptive analysis. J Health Soc Sci 2020;5(2): 251−64. https://doi.org/10.19204/2020/rlym10.
[88] World Health Organization [WHO]. Novel corona virus situation updates Maldives. 06 Oct 2020 [cited 2020 Dec 12]. Available from: https://www.who.int/maldives/news/detail/31-01-2020-updates-on-novel-corona-virus-(COVID-19).
[89] Adhikary P, Balen J, Gautam S, Ghimire S, Karki JK, Lee AC, et al. The COVID-19 pandemic in Nepal: emerging evidence on the effectiveness of action by, and cooperation between, different levels of government in a federal system. J Karnali Acad Health Sci 2020;3(3):1−11.
[90] Sapkota K, Dangal G, Koirala M, Sapkota K, Poudel A, Dhital SR. Strategies for prevention and control of COVID-19 in Nepal. J Patan Acad Health Sci 2020;7(1):85−8. https://doi.org/10.3126/jpahs.v7i1.28879.
[91] Noreen N, Naveed I, Dil S, Niazi SUK, Saleem S, Mohiuddin N, et al. Trend analysis of exponential increase of Covid-19 cases in Pakistan: an interpretation. Global Biosec 2020;2(1). https://doi.org/10.31646/gbio.66.
[92] Ashfaq M, Bashir M. Pakistan: making a "COVID budget" in a struggling economy. J Public Budg Account Financ Manag 2020;33(1):69−77. https://doi.org/10.1108/JPBAFM-07-2020-0118.
[93] WHO Eastern Mediterranean Region. Pakistan receives first consignment of COVID-19 vaccines via COVAX facility [cited 2021 May 17]. Available from: http://www.emro.who.int/media/news/pakistan-receives-first-consignment-of-covid-19-vaccines-via-covax-facility.html.
[94] Erandi KKWH, Mahasinghe AC, Perera SSN, Jayasinghe S. Effectiveness of the strategies implemented in Sri Lanka for controlling the COVID-19 outbreak. J Appl Math 2020;2020: 2954519. https://doi.org/10.1155/2020/2954519.
[95] Jayasena H, Chinthaka W. COVID-19 and developing countries: lessons learnt from the Sri Lankan experience. J R Soc Med 2020; 113(11):464−5. https://doi.org/10.1177/0141076820947367.
[96] WHO South-East Asia Regional Office. COVID-19 weekly situation report: week #04 (25 January - 31 January) [cited 2021 Mar 12]. Available from: https://cdn.who.int/media/docs/default-source/searo/whe/coronavirus19/sear-weekly-reports/searo-weekly-situation-report-4.pdf?sfvrsn=51bb8bd5_4.
[97] Worldometers. COVID live update [cited 2021 Jul 18]. Available from: https://www.worldometers.info/coronavirus/.
[98] Callaway E. Delta coronavirus variant: scientists brace for impact. Nature 2021;595(7865):17−8. https://doi.org/10.1038/d41586-021-01696-3.
[99] World Health Organization [WHO]. Health workforce requirements for universal health coverage and the sustainable development goals: background paper No. 1 to the global strategy on human resources for health [cited 2021 Jul 12]. Available from: https://apps.who.int/iris/handle/10665/250330.
[100] Karan A, Negandhi H, Hussain S, Zapata T, Mairembam D, De Graeve H, et al. Size, composition and distribution of health workforce in India: why, and where to invest? Hum Resour Health 2021;19(1):39. https://doi.org/10.1186/s12960-021-00575-2.
[101] World health Organization [WHO]. World health statistics 2021 [cited 2021 Jul 1]. Available from: https://www.who.int/data/gho/publications/world-health-statistics.
[102] Islam S, Islam R, Mannan F, Rahman S, Islam T. COVID-19 pandemic: an analysis of the healthcare, social and economic challenges in Bangladesh. Prog Dis Sci 2020;8:100135. https://doi.org/10.1016/j.pdisas.2020.100135.
[103] Biswas RK, Huq S, Afiaz A. Relaxed lockdown in Bangladesh during COVID-19: should economy outweigh health? Int J Health Pol Manag 2020;9(11):488−90. https://doi.org/10.34172/ijhpm.2020.98.
[104] Chaudhry ZZ. Double mutant B. 1.617. 2 variant driving the second wave of Coronavirus in India [cited 2021 Jul 19]. Avialable from: https://scientiamag.org/double-mutant-b-1-617-2-variant-driving-the-second-wave-of-coronavirus-in-india/?utm_source=rss&utm_medium=rss&utm_campaign=double-mutant-b-1-617-2-variant-driving-the-second-wave-of-coronavirus-in-india.
[105] Bhuyan A. Experts criticise India's complacency over COVID-19. Lancet 2021;397(10285):1611−2. https://doi.org/10.1016/S0140-6736(21)00993-4.