ORIGINAL ARTICLE OPEN ACCESS

# THE PREVALENCE OF COVID-19 IN HIGH-RISK DISTRICT OF KPK, MARDAN, PAKISTAN

**Haider Ali Khan[1], Mehran Ullah[2], Mehreen Ghufran[3], Muhammad Siddiq[4], Kachkol Khan[5], Muhammad Mussadiq Gul[6]**

*[1]Department of Health, THQ Takht Bhai,Mardan, &[2]Department of Biochemistry, Abdul Wali Khan University Mardan, Pakistan Govt KPK, Pakistan*

## ABSTRACT

**Objectives:** to investigate the prevalence of COVID-19 and to find out the prevalence of COVID-19 positive individuals with full-vaccination, partial-vaccination and those who were non-vaccinated individuals in Mardan, Khyber Pakhtunkhwa, Pakistan.

**Study Design:** this Multi-center retrospective study was carried out to determine the prevalence of COVID-19 in children, adults and aged old individuals using RT-PCR as a method of detection.

**Place and Duration of the Study:** Department of Pathology at Mardan Medical Complex from August 1st, 2021 to August 31st 2021.

**Methodology:** A random sample was taken from the population as well as all suspected persons who were admitted to various isolation wards and quarantine centres throughout District Mardan to be tested. The real-time RT-PCR tests were performed for testing the COVID-19 samples. The statistical analysis was performed with a 5% significance level.

**Results:** A total of 2960 samples were collected. Among all the samples, 1536 individuals were male while females were 1424. The ages of the participants ranged from 0 to 80 years, with the average age being 40 years. The patients' median age was discovered to be 40.66 years. The youngest patient was only 1.5 months old, and the oldest patient was 80 years old. Males were particularly affected when compared to females. The RT-PCR tests were performed for testing the COVID-19 samples. The overall prevalence in Mardan was found 10.03 % (297 out of 2960), in which 161 out of 1536 (10.48%) were males positive cases and 136 out of 1424 (9.55%) were female positive COVID-19 cases whereas 2663 out of 2960 (89.96%) were reported as negative COVID-19 cases.

**Conclusions:** The prevalence of COVID-19 in the Mardan district is extremely high, necessitating the implementation of WHO-recommended SOPs to control the spread of COVID-19.

**Keywords:** Sars-Corona virus-2, COVID-19, Prevalence, RT-PCR, Statistical Package for Social Sciences version 28 (SPSSv28), Mardan Khyber Pakhtunkhwa, Pakistan

**How To Cite This Article:** **Khan HA, Ullah M, Ghufran M, Siddiq M, Said KK, Gul MM**. The prevalence of COVID-19 in a high-risk district of Khyber Pakhtunkhwa, Mardan, Pakistan: Original article. **J Bacha Khan Med Coll**. 2024;5(2):**179-187.**

**Correspondence Author: Haider Ali Khan**
Assistant Professor Department of Biochemistry, Abdul Wali Khan University Mardan, Pakistan
**E-mail:** drhaideralikhancmc@gmail.com
https://orcid.org/0009-0008-5315-9492

**Received:** 22nd July, 2024
**Revised:** 10th September, 2024
**Accepted:** 21st November, 2024
**Published:** 1st January, 2025
**DOI:** https://doi.org/10.69830/jbkmc.v5i02.179

## INTRODUCTION

Several cases of pneumonia were reported in Wuhan, China's Hubei province, the epicentre of the outbreak (1). On March 11, 2020, the World Health Organization (WHO) declared COVID-19 a global pandemic(2). Multiple epidemiological studies reported that the COVID-19 was discovered on December 8, 2019 in Wuhan, China (3-6). This disease later spread throughout the world, including Iran, Europe, India, the United Kingdom (UK), and Pakistan, and it was declared a pandemic on March 11, 2020 (6, 7). The first case of this disease was discovered in Pakistan at the end of February 2020 (8, 9). COVID-19 is highly contagious, and it spreads.through.human-to-human transmissions(10). From the 3rd of January 2020 to the 8th of September 2021, there were 1,186,234 confirmed cases of COVID-19 in Pakistan, with a total of 26,330 Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) was discovered as the unique coronavirus that causes the Coronavirus Disease 2019 (COVID-19) pandemic (11, 12). COVID-19 has spread worldwide since its emergence, with the World Health Organization reporting over 71 million confirmed cases and 1.6 million deaths (WHO). COVID-19 positive cases are on the rise and are found all over the world, with the highest prevalence in America, followed by Europe and Southeast Asia, and the lowest in the Western Pacific region. Patients who are asymptomatic or have moderate symptoms can recover at home with isolation, whereas those who have serious consequences, such as acute respiratory distress syndrome (ARDS), need to be admitted to an intensive care unit (ICU) and receive oxygen therapy (12, 13). The coronavirus is encased in an extremely large positive-sense strand of the RNA genome, which mutates very quickly due to RNA errors (14, 15). It is very contagious and can be found in a variety of species due to its constant mutation (16, 17). CoVs are divided into four genera: (I) α-coronavirus (alphaCoV), (II) β- coronavirus (betaCoV), and (III) δ-coronavirus (deltaCoV), and (IV) γ-coronavirus (gammaCoV), which are likely to be found in bats and rodents, respectively (18-20). The virus has a natural and zoonotic origin: I natural selection in an animal host before zoonotic transmission; and (ii) natural selection in humans after zoonotic transmission are two hypotheses that can plausibly explain the genesis of SARS-CoV2 (18, 20). SARS-CoV-2 is an enveloped β-coronavirus that has an 80% genomic sequence with SARS-CoV-1 and the bat coronavirus RaTG13 (96.2 percent) (21). Spike (S) glycoprotein, envelope (E), and membrane (M) proteins coat the viral envelope. The S protein is responsible for host cell binding and entrance. The virus binds to a host cell via its target receptor, which is the initial stage in infection. The receptor binding region of the S protein binds to the peptidase domain of angiotensin-converting enzyme 2 in the S1 subunit (ACE 2). The S2 subunit is substantially conserved in SARS-CoV-2 and is thought to be a potential antiviral target.Some patients in Pakistan have been known to be asymptomatic, which could make them a carrier of the disease if not treated appropriately (22, 23). The goal of this research is to carefully analyse the prevalence and clinical aspects of COVID-19 in District Mardan, KPK, Pakistan. This research will show a link between epidemiological and clinical factors, which could be useful in preventing the virus's spread in Pakistan. This study also include the fully vaccinated, partially vaccinated and non- vaccinated people. It is concluded from this study that non-vaccinated patient are more affected by Sars-corona virus than partially and fully vaccinated people. The highly affected district of Khyber Pakhtunkhwa Pakistan was Mardan when first confirmed fatal case of corona virus case was identified in a 50 year old man that is Mr. Sadat khan after foreign trip from Saudi Arabia in March 2020. This study includes the contact tracing of corona positive patient. The asymptomatic positive patients are identified and they are isolated for 14 days. The minor symptomatic patients are treated for their symptoms while serious patient are advice to shift hospital for proper treatment.

## METHODOLOGY

### Study Design and Setting

This retrospective, multi-center study was conducted from August 1 to August 31, 2021, at quarantine centers and healthcare facilities in District Mardan, including the Mardan Medical Complex.

### Study Population

The study included 2,960 individuals with COVID-19 symptoms, asymptomatic individuals, and close contacts of confirmed cases admitted to quarantine facilities and hospitals across District Mardan during the study period. 2960 individuals who had COVID-19 symptoms for instance cough, shortness of breath, fever, and body aches, as well as participants who did not experience such symptoms (asymptomatic) and those who were exposed to COVID-19 patients who were admitted in District Mardan quarantine centres, including the Mardan Medical Complex. These three aspects of the population, epidemiological state, and clinical manifestations were recorded.

### Ethical Approval Statement:

Ethical approval for this study was granted by the Institutional Review Board of Abdul Wali Khan University Mardan **(Ref No: AWKU-303-01-2023).** All participants provided informed consent prior to enrollment. Confidentiality and anonymity of patient data were strictly maintained throughout the study

### Inclusion Criteria:

- Individuals aged 18 years and above who presented with COVID-19 symptoms, including cough, fever, shortness of breath, and body aches.
- Asymptomatic individuals who had confirmed exposure to COVID-19 patients.
- Patients admitted to District Mardan quarantine centers, including Mardan Medical Complex.
- Individuals who provided informed consent for participation in the study.

**Exclusion Criteria:**

- Patients with incomplete medical records or missing epidemiological data.
- Individuals who refused to provide consent for participation.
- Patients with a history of chronic respiratory illnesses that could confound COVID-19 symptomatology.
- Individuals who had received a confirmed COVID-19 diagnosis more than 14 days prior to data collection.

## SAMPLE COLLECTION

Nasopharyngeal swab samples were obtained at random from the community and from all suspected people admitted to various isolation wards and quarantine centres across District Mardan, in accordance with WHO recommendations. These samples were subsequently submitted to the Mardan Medical Complex (MMC) Hospital, KMU, and the Islamabad Diagnostic Center for additional analysis. During sample collection and shipment, all relevant standard operating procedures were followed.

## SAMPLE PROCESSING

A skilled nurse took nasopharyngeal and oropharyngeal swab samples from each participant during the same visit. SARS-CoV-2 detection was done using real-time RT-PCR.All of the samples were then examined using RT- PCR for COVID-19 diagnosis and SARS-CoV-2 RNA/genome detection.

## STATISTICAL ANALYSIS

Using Statistical Package for Social Sciences version 28 (SPSSv28) and Excel, the data were analysed. It was reported that percentages were employed to represent data. Categorical data were analysed using a Chi-square test. The $P<0.05$ was significant at the 5% significance level.

## RESULTS

As of August 1st, 2021, epidemiological data of 2960 individuals were collected from District Mardan, Khyber Pakhtunkhwa (KPK) Pakistan. A total of 2960 patients' medical records were examined. The median age of these patients was found to be 40.66 years. The youngest patient was 1.5 months old, whereas the oldest one was 80years of age. Among all the samples, 1536 individuals were male while females were 1424. The ages of the participants ranged from 0 to 80 years, with the average age being 40 years. Males were disproportionately affected when compared to females. The COVID-19 samples were tested using RT-PCR techniques. In Mardan, the overall prevalence was found to be 10.03 percent (297 out of 2960), in which 161 out of 1536 (10.48%) were Out of the total tested, 136 of 1424 (9.55) percent of females tested positive in relation to COVID-19, and 2663 of 2960 percent (89.96) of the population was negative. Table 1 shows that a significant correlation existed between gender and COVID-19 positivity, evidenced clearly by Figure 1.The immune response to COVID-19 RT-PCR positivity by age grouping also showed statistically significant relationship ($P < 0.05$). All the age bands, including 0-9, 11-20, 21-30, 31-40, 41-50, 51-60, 61-70, and 71-80 are highly significant with P-values being less than 0.05. The age category 31-40 years had the highest number of positive cases 41/300 (13.67) and 30/300 (10%). The 4150 years age group came next with 29 males and 32 females returning positive. Gender and age distribution of positive cases is analyzed in detail in Table 1 and Figure 1.The research study also involved fully vaccinated, partially vaccinated, and unvaccinated study groups aged 21 to 30, 30 to 40, 40 to 50, 50 to 60, 60 to 70, and 70 to 80. The results indicated that unvaccinated persons had a higher SARS-CoV-2 test positivity than partially or completely vaccinated citizens, as presented in Table 2-3 and Figure 2-3. Among the positive cases, those who had been completely and partially vaccinated were asymptomatic, whereas the unvaccinated group only developed symptoms.Symptoms reported by symptomatic individuals were headaches, body aches, vomiting, diarrhea, dizziness, fever, sore throat and dry cough. The most common comorbidity recorded on COVID positive patients was hypertension, then diabetes, heart disease, asthma, and hypercholesterolemia, among less significant conditions. Particularly, asymptomatic cases in vaccinated subjects were commonly associated with such co-morbidities, as presented in Tables 23 and Figures 23.The analysis was conducted in IBM SPSS Statistics 28, and Pearson Chi-square was used. The results were significant ($P < 0.05$) across all results in support of the alternate hypothesis and the rejection of the null hypothesis. The Chi-square test strengthened the fact that there was a significant correlation between age groups and gender. The data used in the research was appropriately tabulated and graphically displayed.

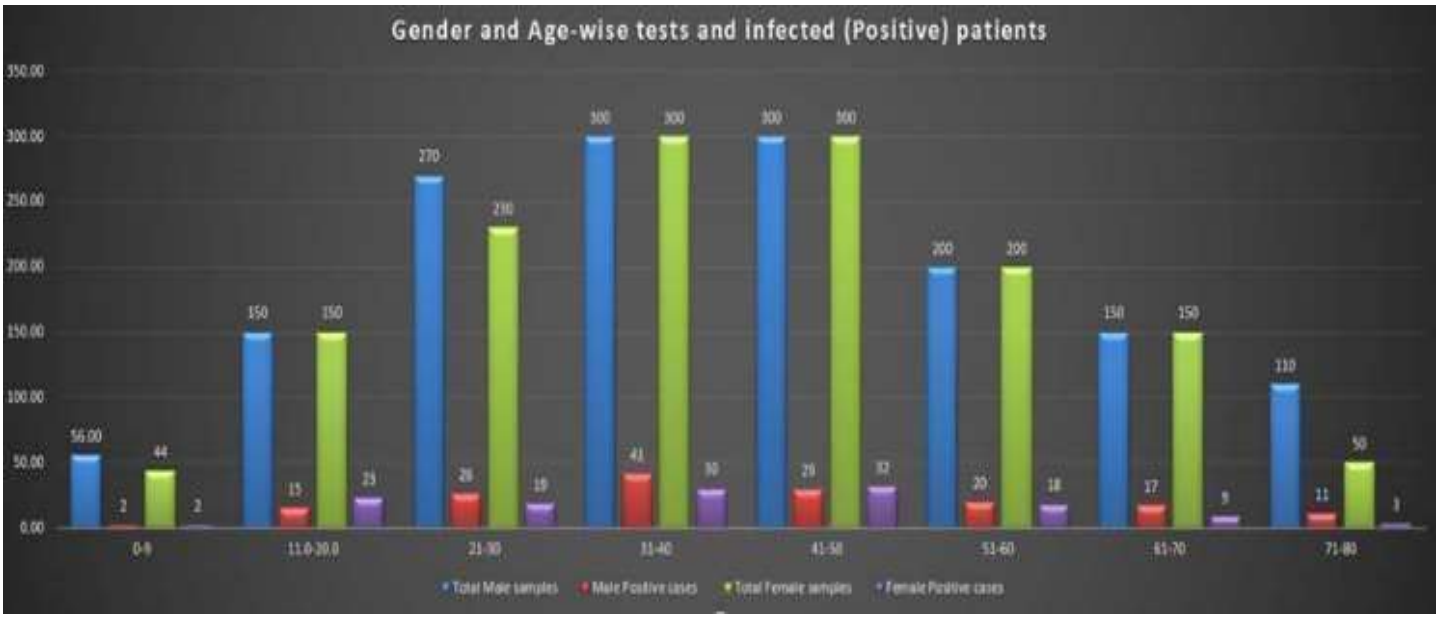


Figure-1: Gender and age distribution of all tested and positive individuals across various groups.

**Table 1: Age and Gender wise distribution of COVID-19 in District Mardan, KPK, Pakistan**

| Age | Total Male Samples | Male Positive cases | ercentage (%) | Total Female Samples | Female Positive cases | ercentage (%) | *P*-value |
|---|---|---|---|---|---|---|---|
| **0-9** | 56.00 | 2 | 3.57 | 44 | 2 | 4.545 | 0.012 |
| **11-20** | 150 | 15 | 9.61 | 150 | 23 | 15.33 | 0.000145 |
| **21-30** | 270 | 26 | 9.63 | 230 | 19 | 12.6 | <0.00001 |
| **31-40** | 300 | 41 | 13.67 | 300 | 30 | 10 | 0.00001 |
| **41-50** | 300 | 29 | 9.67 | 300 | 32 | 10.66 | 0.0001 |
| **51-60** | 200 | 20 | 10.00 | 200 | 18 | 9 | <0.00001 |
| **61-70** | 150 | 17 | 11.33 | 150 | 9 | 6 | 0.00001 |
| **71-80** | 110 | 11 | 10.00 | 50 | 3 | 6 | 0.000143 |
| **Total** | 1536.00 | 161 | | 1424 | 136 | | 0.01242 |

**P-value < 0.05 was considered significant*

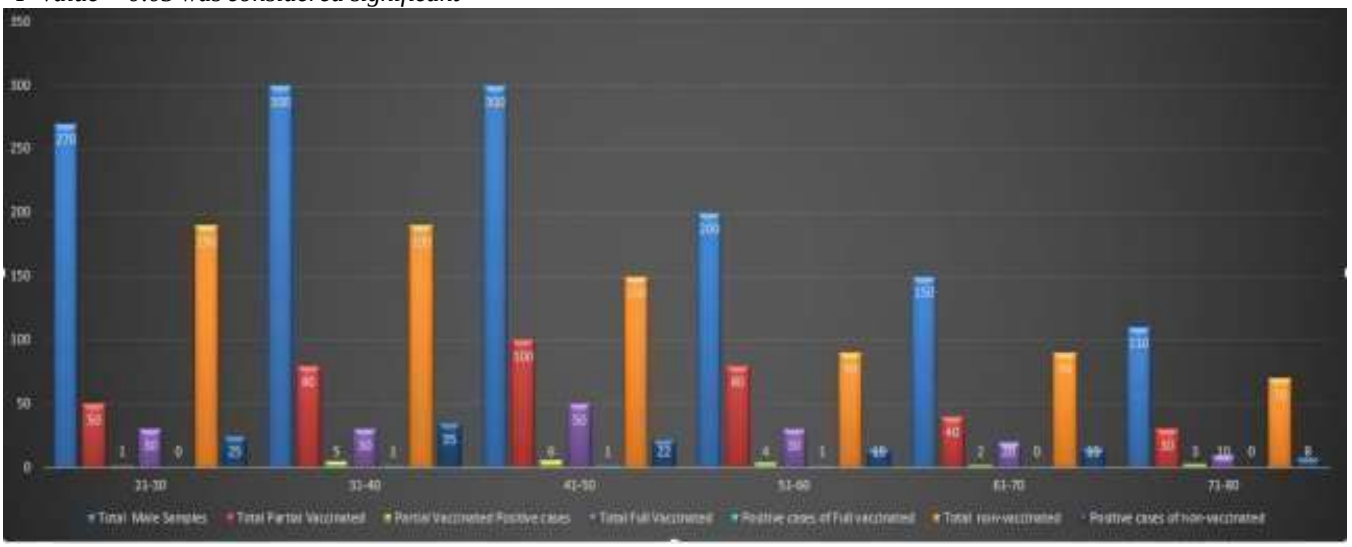

Figure-2: Age-wise distribution of all the total samples of fully vaccinated, partially vaccinated and non-vaccinated male individuals and positive individuals among various groups.

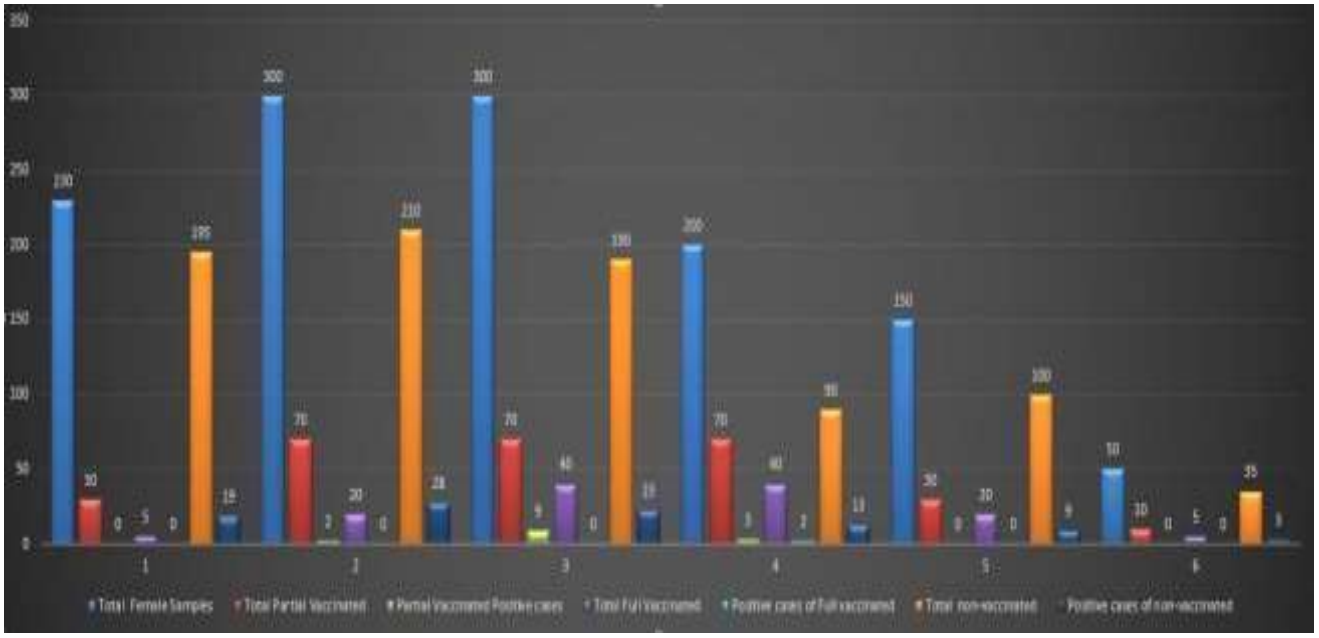

Figure-3: Age-wise distribution of all the total samples of fully vaccinated, partially vaccinated and non-vaccinated female individuals and positive individuals among various groups.

**Table-2: Age-wise distribution of all non-vaccinated, partially vaccinated and fully vaccinated Male individuals**

| Age | Total Male Samples | Total Partial Vaccinated | Partial Vaccinated Positive cases | Total Full Vaccinated | Positive cases of Full vaccinated | Total non-vaccinated | Positive cases of non-vaccinated |
|---|---|---|---|---|---|---|---|
| **21-30** | 270 | 50 | 1 | 30 | 0 | 190 | 25 |
| **31-40** | 300 | 80 | 5 | 30 | 1 | 190 | 35 |
| **41-50** | 300 | 100 | 6 | 50 | 1 | 150 | 22 |
| **51-60** | 200 | 80 | 4 | 30 | 1 | 90 | 15 |
| **61-70** | 150 | 40 | 2 | 20 | 0 | 90 | 15 |
| **71-80** | 110 | 30 | 3 | 10 | 0 | 70 | 8 |

*All of the findings were statistically significant, with a P-value of less than 0.05.*

**Table-3: Age-wise distribution of all non-vaccinated, partially vaccinated and fully vaccinated Female individuals**

| Age | Total Female Samples | Total Partial Vaccinated | Partial Vaccinated Positive cases | Total Full Vaccinated | Positive cases of Full vaccinated | Total non-vaccinated | Positive cases of non-vaccinated |
|---|---|---|---|---|---|---|---|
| **21-30** | 230 | 30 | 0 | 5 | 0 | 195 | 19 |
| **31-40** | 300 | 70 | 2 | 20 | 0 | 210 | 28 |
| **41-50** | 300 | 70 | 9 | 40 | 0 | 190 | 23 |
| **51-60** | 200 | 70 | 3 | 40 | 2 | 90 | 13 |
| **61-70** | 150 | 30 | 0 | 20 | 0 | 100 | 9 |
| **71-80** | 50 | 10 | 0 | 5 | 0 | 35 | 3 |

*All of the findings were statistically significant, with a P-value of less than 0.05.*

## DISCUSSIONS

The widely spread of COVID-19, which was caused by a novel coronavirus (SARS-CoV-2), from its epicentre in Wuhan, China, to every nook and cranny of the world after December 2019, threatens the current global health system and has raised serious concerns about human safety, according to the World Health Organization (24). COVID-19 was labelled a pandemic by the World Health Organization (WHO) on March 20, 2020, due to its rapid global spread. According to the latest statistics from August 7, 2020, there were 19.2 million illnesses and 717,754 mortality cases. Fever, coughing, dyspnea, myalgia, shortness of breath, and radiographic indications of ground-glass lung opacities associated with atypical pneumonia are common symptoms in COVID-19 patients. However, some patients have been described with asymptomatic or minimally symptomatic instances (11, 18, 25). According to data from August 07, 2020, the massive number of verified COVID- 19 positive (19.2 million) and mortality cases (717,754) indicates that the entire world has failed to cope with the current urgent corona situation. SARS-rapid CoV-2's spread around the globe had a negative impact on human health, thus researchers devised a variety of techniques to battle and contain the chaos caused by this infection.The COVID-19 epidemic has had a terrible impact on people all across the world. According to the World Health Organization, the COVID-19 has spread to 220 countries and areas around the world. On February 26, 2020, Pakistan announced the first instance of COVID-19, and as of today, about 0.42 million individuals have been affected,with more than eight thousand deaths as a result of the virus. Following an unexpected increase in the number of Covid-19 cases in Pakistan, the government of Pakistan implemented a number of measures, including the suspension of internal flights and local transportation, a complete lockdown, the establishment of quarantine centres, isolation wards, and special hospitals for COVID-19 patients, as well as public awareness campaigns in electronic, print, and social media to try and reduce the spread of the virus.In this study, 2960 people from the Mardan District of Khyber Pakhtunkhwa were surveyed and evaluated. Rotor-Gene Q real-time PCR was used to screen all of the collected samples for SARS-CoV-2 infection using the Rotor-Gene Q system. The results of infected individuals were remarkable, and they provided substantial evidence of SARS-CoV-2 infection.Based on RT-PCR results, we discovered

that SARS-CoV-2 symptoms appeared within three weeks of the onset of the virus's symptoms. Individuals with a variety of conditions, as well as the elderly, were shown to be more vulnerable to and show more symptoms of SARS-CoV-2. In addition, previous studies revealed that coronavirus is more likely to infect older people, in whom the immunopathogenesis and development of a prion flammatory cytokine secretion may be responsible for the infection (6). Aged people with a sluggish immune system can take weeks to be completely free of the virus. There are many instances of false-negative RT-PCR results for SARSCoV-2 in clinical settings, and mistakes in collection and testing. Additionally, the Ministry of National Health Services, Govt of Pakistan recommends that if a patient has achieved relief from symptoms,radiographic improvement, and two consecutive negative RT-PCR results for SARS-CoV-2, they can be discharged from the hospital (http://covid.gov.pk/).In this study, it was found that females (9.55 percent) were less likely to be infected than males (10.48 percent). Our findings agreed with another recent study from China, where the infection rate was shown to be much higher in males (11)(26). This is interesting; prior research has shown that male mice are more susceptible to the SARS-CoV and MERS-CoV than females (27). The initial source of the virus's transmission may be linked to the foreign workers who were transferred from Iran to Pakistan (28). The first verified fatal case of COVID-19 in Mardan, Pakistan was a 50-year-old man who returned from Saudi Arabia on March 09, 2020 and reported with cough, fever, depression, low appetite, and difficulty in breathing to the Pulmonologist at District Headquarter Hospital Mardan (29).Human-to-human spreading of the disease is already well documented (30). Individuals who had more contact with the public were shown to be at an increased risk of contracting the disease. Another interesting consequence of the March religious organizations was an increase in the number of incidents. As a result, social isolation should be encouraged so as to keep the sickness from propagating out of control (31). Such instances may have been exacerbated by a lack of personal protective equipment (PPE), prolonged exposure to patients, and a lack of knowledge of disease transmission among healthcare providers(32). Increased self-protection awareness, proper PPE supplies, and a quick reaction may help reduce infection susceptibility among healthcare personnel (33). Hypertension, diabetes, cardiovascular disease, and asthma were the most common comorbidities in our study. Different studies observed a similar pattern, with hypertension being the most common co-morbidity, followed by diabetes, heart disease, and respiratory ailments (34). Other research found the same pattern as the previous ones, with hypertension, diabetes, and cardiovascular illnesses being the most common co-morbidities (35).This current study is among the first to depict the prevalence of COVID-19 cases in Mardan, KPK, Pakistan, among those who were fully vaccinated, those who were partially vaccinated, and those who were not immunized (non-vaccinated). Although Pakistan is a lower-middle-income country, it has numerous difficulties, like inadequate health facilities and a socioeconomic system that leaves many people in poverty. Identifying and creating a response that could lessen the early onset of disease may be one possible outcome of our investigation.

## CONCLUSION

The virus's first source of propagation could be traced back to foreigners visiting Pakistan. Men had a higher rate of spread than women. The most common symptoms are fever, cough, lethargy, and headache. A small number of positive cases were discovered to have had direct contact with pets or livestock. The most prevalent co-morbidities are hypertension, diabetes, and cardiovascular disease. The most important conclusion of this study was that the non-vaccinated patient are more affected by Sars-corona virus 2 than partially and fully vaccinated people, because of the developed immune system of the partially and fully vaccinated people. The current study suggests that the COVID-19 prevalence rate in District Mardan, Khyber Pakhtunkhwa, is far too high. The rate of occurrence is 10.03 percent. The age group 31-40 is the most affected, with a male to female ratio of 2:1 overall.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

## FUNDING

The authors did not receive any funding for this work.

## PATIENT CONSENT

The consent of the patients/guardians was taken from all the participants prior to the writing of the manuscript.

## AUTHOR CONTRIBUTIONS

**HAK:**Conceptualization,study-design, and manuscript drafting.

**MU:**Data-collection-methodology development and critical revision of the manuscript.

**MG:** Statistical analysis, data interpretation, and manuscript editing.

**MS:** Literature review, validation, and quality

**KK:**Supervision,visualization, and final approval of the manuscript.

**MMG**:Final editing, formatting, and overall coordination of the study.

All Authors Have Reviewed And Approved The Final Version Of The Manuscript.

## REFERENCES


1. Albright A, Gross K, Hunter M, O'Connor L. A Dispatch Screening Tool to Identify Patients at High Risk for COVID-19 in the Prehospital Setting. The western journal of emergency medicine. 2021;22(6):1253-6.

2. Alqahtani SA, Buti M. COVID-19 and hepatitis B infection. Antiviral therapy. 2020;25(8):389-97.

3. Barreiro P, Candel FJ, Carretero MM, San Román J. Risk of severe COVID in solid organ transplant recipient. Revista espanola de quimioterapia : publicacion oficial de la Sociedad Espanola de Quimioterapia. 2023;36 Suppl 1(Suppl 1):15-7.

4. Bottrighi A, Pennisi M, Roveta A, Massarino C, Cassinari A, Betti M, et al. A machine learning approach for predicting high risk hospitalized patients with COVID-19 SARS-Cov-2. BMC medical informatics and decision making. 2022;22(1):340.

5. Brito-Dellan N, Tsoukalas N, Font C. Thrombosis, cancer, and COVID-19. Supportive care in cancer : official journal of the Multinational Association of Supportive Care in Cancer. 2022;30(10):8491-500.

6. Butt AA, Yan P, Shaikh OS, Omer SB, Mayr FB, Talisa VB. Molnupiravir Use and 30-Day Hospitalizations or Death in a Previously Uninfected Nonhospitalized High-risk Population With COVID-19. The Journal of infectious diseases. 2023;228(8):1033-41.

7. Carle C, Hughes S, Freeman V, Campbell D, Egger S, Caruana M, et al. The risk of contracting SARS-CoV-2 or developing COVID-19 for people with cancer: A systematic review of the early evidence. Journal of cancer policy. 2022;33:100338.

8. Chagla Z. In high-risk adults, the Moderna vaccine had 94% efficacy against COVID-19 ≥14 d after the 2nd dose. Annals of internal medicine. 2021;174(3):Jc28.

9. Cui X, Zhao Z, Zhang T, Guo W, Guo W, Zheng J, et al. A systematic review and meta-analysis of children with coronavirus disease 2019 (COVID-19). Journal of medical virology. 2021;93(2):1057-69.

10. Delpuech O, Douthwaite JA, Hill T, Niranjan D, Malintan NT, Duvoisin H, et al. Heat inactivation of clinical COVID-19 samples on an industrial scale for low risk and efficient high-throughput qRT-PCR diagnostic testing. Scientific reports. 2022;12(1):2883.

11. Dryden-Peterson S, Kim A, Kim AY, Caniglia EC, Lennes IT, Patel R, et al. Nirmatrelvir Plus Ritonavir for Early COVID-19 in a Large U.S. Health System : A Population-Based Cohort Study. Annals of internal medicine. 2023;176(1):77-84.

12. El Karoui K, De Vriese AS. COVID-19 in dialysis: clinical impact, immune response, prevention, and treatment. Kidney international. 2022;101(5):883-94.

13. Feikin DR, Higdon MM, Abu-Raddad LJ, Andrews N, Araos R, Goldberg Y, et al. Duration of effectiveness of vaccines against SARS-CoV-2 infection and COVID-19 disease: results of a systematic review and meta-regression. Lancet (London, England). 2022;399(10328):924-44.

14. Gharbharan A, Jordans C, Zwaginga L, Papageorgiou G, van Geloven N, van Wijngaarden P, et al. Outpatient convalescent plasma therapy for high-risk patients with early COVID-19: a randomized placebo-controlled trial. Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases. 2023;29(2):208-14.

15. Graña C, Ghosn L, Evrenoglou T, Jarde A, Minozzi S, Bergman H, et al. Efficacy and safety of COVID-19 vaccines. The Cochrane database of systematic reviews. 2022;12(12):Cd015477.

16. Haider T, Gour V, Pandey V, Kanwar IL, Tiwari R, Vishwakarma M, et al. COVID-19 Infection: Targeting Possibilities for Treatment. Critical reviews in therapeutic drug carrier systems. 2021;38(3):75-115.

17. Heudel P, Favier B, Solodky ML, Assaad S, Chaumard N, Tredan O, et al. Survival and risk of COVID-19 after SARS-COV-2 vaccination in a series of 2391 cancer patients. European journal of cancer (Oxford, England : 1990). 2022;165:174-83.

18. Jones NK, Ramsay I, Moore E, Fuld J, Adcock C, Banham-Hall E, et al. Admission COVID-19 clinical risk assessment for guiding patient placement and diagnostic testing strategy. Clinical medicine (London, England). 2021;21(2):e140-e3.

19. Kampouri E, Hill JA, Dioverti V. COVID-19 after hematopoietic cell transplantation and chimeric antigen receptor (CAR)-T-cell therapy. Transplant infectious disease : an official journal of the Transplantation Society. 2023;25 Suppl 1:e14144.

20. Kreuzberger N, Hirsch C, Andreas M, Böhm L, Bröckelmann PJ, Di Cristanziano V, et al. Immunity after COVID-19 vaccination in people with higher risk of compromised immune status: a scoping review. The Cochrane database of systematic reviews. 2022;8(8):Cd015021.

21. Langerbeins P, Hallek M. COVID-19 in patients with hematologic malignancy. Blood. 2022;140(3):236-52.

22. Lewis E, Fine N, Miller RJH, Hahn C, Chhibber S, Mahe E, et al. Amyloidosis and COVID-19: experience from an amyloid program in Canada. Annals of hematology. 2022;101(10):2307-15.

23. Li H, Gao M, You H, Zhang P, Pan Y, Li N, et al. Association of Nirmatrelvir/Ritonavir Treatment on Upper Respiratory Severe Acute Respiratory Syndrome Coronavirus 2 Reverse Transcription-Polymerase Chain Reaction (SARS-Cov-2 RT-PCR) Negative Conversion Rates Among High-Risk Patients With Coronavirus Disease 2019 (COVID-19). Clinical infectious diseases : an official publication of the Infectious Diseases Society of America. 2023;76(3):e148-e54.

24. Li L, Robinson LB, Patel R, Landman AB, Fu X, Shenoy ES, et al. Association of Self-reported High-Risk Allergy History With Allergy Symptoms After COVID-19 Vaccination. JAMA network open. 2021;4(10):e2131034.

25. Mason A, Anver H, Lwin M, Holroyd C, Faust SN, Edwards CJ. Lupus, vaccinations and COVID-19: What we know now. Lupus. 2021;30(10):1541-52.

26. Naidoo DB, Chuturgoon AA. The Potential of Nanobodies for COVID-19 Diagnostics and Therapeutics. Molecular diagnosis & therapy. 2023;27(2):193-226.

27. Najjar-Debbiny R, Gronich N, Weber G, Khoury J, Amar M, Stein N, et al. Effectiveness of Paxlovid in Reducing Severe Coronavirus Disease 2019 and Mortality in High-Risk Patients. Clinical infectious diseases : an official publication of the Infectious Diseases Society of America. 2023;76(3):e342-e9.

28. Pal R, Bhadada SK, Misra A. COVID-19 vaccination in patients with diabetes mellitus: Current concepts, uncertainties and challenges. Diabetes & metabolic syndrome. 2021;15(2):505-8.

29. Palaniswamy H, Pednekar P, Rajoo S, Gunasekaran K. Preprocedural COVID-19 Testing for High Risk Procedures. Chest. 2021;160(4):e371.

30. Saadi SM, Bossei AA, Alsulimani LK. Acute myocarditis after COVID-19 vaccination. Saudi medical journal. 2022;43(11):1270-5.

31. Seon JY, Kim S, Hong M, Lim MK, Oh IH. Risk of COVID-19 diagnosis and death in patients with mental illness: a cohort study. Epidemiology and psychiatric sciences. 2021;30:e68.

32. Shimizu H, Kawase J, Hayashi M, Imaizumi K, Ito Y, Okazawa M. COVID-19 symptom-onset to diagnosis and diagnosis to treatment intervals are significant predictors of disease progression and hospitalization in high-risk patients: A real world analysis. Respiratory investigation. 2023;61(2):220-9.

33. Srikanth S, Boulos JR, Dover T, Boccuto L, Dean D. Identification and diagnosis of long COVID-19: A scoping review. Progress in biophysics and molecular biology. 2023;182:1-7.

34. Thümmler L, Lindemann M, Horn PA, Lenz V, Konik M, Gäckler A, et al. Early Treatment with Monoclonal Antibodies or Convalescent Plasma Reduces Mortality in Non-Vaccinated COVID-19 High-Risk Patients. Viruses. 2022;15(1).

35. Zeng B, Zhou J, Peng D, Dong C, Qin Q. The prevention and treatment of COVID-19 in patients treated with hemodialysis. European journal of medical research. 2023;28(1):410.