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KNOWLEDGE, ATTITUDE AND COVERAGE OF DIFFERENT COVID-19 VACCINES AMONG GENERAL POPULATION OF DISTRICT MUZAFFARABAD, AJ&K, PAKISTAN

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ABSTRACT

Background: The highly contagious respiratory disease, COVID-19, originating from the SARS-CoV-2 virus, has rapidly spread globally, causing significant human suffering and economic losses. This study in district Muzaffarabad, AJ&K, Pakistan, focuses on assessing knowledge, attitude, and coverage of diverse COVID-19 vaccines among the general population.

Methods: Executing a cross-sectional survey, data from every union council in district Muzaffarabad was collected, incorporating both primary and secondary sources. GraphPad Prism (version 7.4) facilitated data analysis, employing multiple linear regression and the Chi-square test for quantitative data analysis.

Results: The study in Muzaffarabad district revealed significant findings on COVID-19 vaccination. A noteworthy 83% participants displayed positive knowledge, alongside a 77.3% positive attitude. Vaccination status disparities emerged, with EPI reporting 29.6% fully vaccinated and 48.1% half vaccinated, while primary sources showed higher figures at 72.2% fully vaccinated and 8.6% half vaccinated, possibly reflecting differences in population size. CanSino proved most effective at 97.9%, with low post-vaccination COVID-19 cases (4.2%), mainly due to missed booster doses. Common side effects included pain at the injection site (55%), fever (47.5%), tiredness (29.2%), headache (23.3%), and muscle pain (21.1%).

Conclusion: In Muzaffarabad, people mostly have knowledge and express a positive attitude towards COVID-19 vaccines. Differences in vaccination numbers between primary and secondary data may be attributed to population sizes. Overall, the vaccination campaign represents a positive stride toward achieving a herd immunity and tackling global COVID-19 challenges in Muzaffarabad.

Keywords: Coverage of Covid-19 vaccines; Knowledge and Attitudes towards Covid-19 vaccines; Covid-19; Covid-19 in Azad Kashmir; Vaccine coverage of Covid-19 in AJ&K; Vaccination of Covid-19 in Muzaffarabad

1. INTRODUCTON

The Coronavirus disease 2019 (COVID-19) pandemic, characterized by rapid spread and high death rates, has led to severe global disruptions [1]. It is a highly contagious respiratory illness caused by the novel SARS-CoV-2 [2]. Since initial emergence of COVID-19 in city of Wuhan in December 2019, it resulted in almost 773 million confirmed cases worldwide with over 6.9 million deaths as of December 24, 2023 [3]. SARS-CoV-2 are enveloped viruses with a single-stranded positive-sense RNA genome and have a large number of nucleotides (29,903). Coronavirus contains four structural proteins encoded in its genome: spike, envelope, membrane, and nucleocapsid [4,5,6]. The first human coronaviruses (HCoVs), E229-CoV and OC43-CoV were discovered in 1966 [7,8]. SARS-CoV2 is an RNA virus with a high mutation rate. There were a number of contagious diseases for which vaccinations were only partially effective, and there were a number of high-profile vaccine failures [9]. All RNA viruses, including SARS-CoV-2, are vulnerable to making errors in their genetic coding during replication. While most of these mutations are fixed by proofreading processes, as the virus proceeds to expand rapidly, favourable sequence variations are gradually building [10].
Vaccination can help reduce the possibility of disease and death and the negative social, economic, and health effects of COVID-19 and future variants [11]. Eight vaccines received WHO approval for usage, such as BNT162b2 (Pfizer/BioNTech), mRNA-1273 (Moderna Biotech), AZD1222 (Oxford/AstraZeneca), CoronaVac (Sinovac), BBIBP-CorV (Sinopharm), COVAXIN (Bharat Biotech), Ad26.COV2. S (Janssen, Raritan), and Covishield (Serum Institute of India) [12]. Vaccinations against COVID-19 have been more widely accessible to people worldwide since December 2020. Two vaccines, ChAdOx; AstraZeneca and Ad26.CoV2.S; Johnson & Johnson, showed initial effectiveness with adenoviruses when there is little previous immunity in the US and Europe [13].

Pfizer-BioNTech and Moderna were both discovered to be 91.2% and 98.1% effective for vaccinated individuals, respectively, while CoronaVac was only shown to be 65.7% effective [14]. The effectiveness of the COVID-19 (inactivated) vaccine (CoronaVac) was 50.7% according to phase III trials [15]. The Sputnik COVID vaccine was reported to be 97.6% effective by the Gamaleya Institute according to the results of 3.8 million Russians who received both doses in April, 2021 [16]. BBIBP-CorV (Sinopharm) and mRNA BNT162b2 (Pfizer-BioNTech) both exhibited 95% and 98% effectiveness for delta variant in completely vaccinated people, respectively [17]. The WHO reported that the effectiveness of the Sinopharm BBIBP-CorV vaccination was approximately 90% for adults after the second dose in a test-negative design performed in Bahrain [18].

In Abu Dhabi Emirate, the BBIBP-CorV was 80%, 92%, and 97% effective in protecting completely vaccinated people from hospitalization, serious illnesses, and death [19]. In Brazil, the CoronaVac vaccination did not protect against symptomatic COVID-19 with a single dose in pregnant women. Two CoronaVac doses were effective against symptomatic COVID-19 in 41% of cases and in 85% of cases of severe COVID-19 [20]. In Pakistan, with adjusted estimates of vaccine effectiveness of 33.8% and 49.3%, the most often given vaccine was Sinopharm (61.6%), with Sinovac (25.6%) coming in second. The mRNA vaccinations were considered to be the most effective at 67.4% [21].

The first doses of the vaccine from the neighboring nation of China were delivered to Pakistan on February 1st, 2021. On June 1, 2021, Pakistan introduced a locally produced single-dose CanSino COVID-19 vaccination with China's collaboration [22]. As of 26 November, 2023, 67% of the population globally received all recommended doses of the COVID-19 primary series vaccination [23]. No such research was done in the district Muzaffarabad in Azad Kashmir. This study in district

Muzaffarabad, AJ&K, Pakistan, focuses on assessing knowledge, attitude, and coverage of diverse COVID-19 vaccines among the general population.

2. MATERIALS AND METHODS

2.1. Study area and study duration

The study took place in the Muzaffarabad district of AJ&K, Pakistan. The district comprises two tehsils: Patika (Naseerabad) and Muzaffarabad, further subdivided into 25 union councils. Conducted from February to July 2022, this cross-sectional study covered all the union councils within the Muzaffarabad district, AJ&K, Pakistan.

2.2. Data collection and procedure

2.2.1. Inclusion and exclusion criteria

Data were gathered through a self-administered interview-based questionnaire method from the general population of the Muzaffarabad district, AJ&K, Pakistan. Individuals aged 12 years and above were included in the study after providing their consent. Those below the age of 12 and individuals unwilling to give consent were excluded from the study.

2.2.2. Data type and sources

A meticulously structured questionnaire was developed to collect the necessary data, consisting primarily of closed-ended questions. Quantitative data collection methods were employed in this study. The research involved both secondary data obtained from the Expanded Programme on Immunization (EPI) and primary data acquired through questionnaires, interviews, and discussions.

2.2.3. Sample size and sampling methods

The sample size was determined using Raosoft software (online tool), with a maintained power of 80%, a response distribution assumption of 50%, a confidence interval set at 95%, and an error margin of 5%. According to the 2017 population census, the total population of the Muzaffarabad district was 650,370. Through calculations with Raosoft software, the recommended minimum population size was found to be 384. In this study, data were systematically collected from a sample of 750 participants using a random sampling approach within the designated time period.

2.3. Statistical analysis

The data obtained from various sources were subjected to quantitative analysis using GraphPad Prism (version 7.4). Multiple linear regression analysis was employed to examine the relationship between participants' age, gender, and marital status with their COVID-19 vaccination status. Additionally, the association between sex and COVID-19 vaccination status across different user (participant) categories was explored using the Chi-square test.

3. RESULTS

3.1. Overall coverage of Covid-19 vaccination in the studied population

In the present study, there were 750 participants from 25 union councils in the district Muzaffarabad. 30 participants were chosen from each UC. 78.9% of participants were in age group of 12 to 31 years found to be vaccinated against COVID-19. Similarly, 80.5% of individuals in age group of 32 to 51 years were found to be vaccinated against COVID-19, while 87.9% of vaccinated individuals were in age group of 52 to 71 years. In the current study, 87.5% of those vaccinated against COVID-19 were in the age group above 71 years as shown in the table 1. However, out of the total 750 participants, 606 (80.8%) respondents were found to be vaccinated; 542 (72.2%) were fully vaccinated, whereas 64 (8.6%) were half-vaccinated, and the remaining 144 (19.2%) were found to be non-vaccinated as shown in Table 1.

Table 1. Age-wise vaccination status of COVID-19 among the participants

Age groups	Total Participants	Vaccinated Individuals	Non-Vaccinated individuals
12-31 Years	369	291(78.9%)	78(21.1%)
32-51 Years	266	214(80.5%)	52(19.5%)
52-71 Years	107	94(87.9%)	13(12.1%)
Above 71 Years	08	07(87.5%)	01(12.5%)

The overall coverage of the COVID-19 vaccine was obtained from the secondary data provided by the Expanded Programme on Immunization (EPI). In Muzaffarabad, a total of 313033 individuals were administered the first dose. The participants were from both tehsils of district Muzaffarabad and multiple health centres were involved in carrying out the vaccination process. Of these 313033 individuals, 192246 (61.4%) of individuals had taken second dose. Out of a total 650,370 population in Muzaffarabad, 192246 (29.6%) were fully vaccinated, while 313033 (48.1%) were half vaccinated (Table 2 and Table 3).

Table 2. Tehsil-based overall coverage of COVID-19 vaccination in district Muzaffarabad

Health Care Unit	Tehsil	First Dose Administered	Second Dose Administered
ADHO Office	Muzaffarabad	5,013	1,262
AIMS	Muzaffarabad	9,879	7,072
AJK University MZD (City Campus)	Muzaffarabad	59,825	49,165
BHU Anwar Sharif	Muzaffarabad	7,065	4,452
BHU Brarkot	Muzaffarabad	2,707	1,455
BHU Dachore Miran	Muzaffarabad	5,563	2,820
BHU Hotreeri	Muzaffarabad	4,245	3,275
BHU Koomi Kot	Muzaffarabad	9,870	5,234
BHU Langerpura	Muzaffarabad	6,515	4,058
BHU Lower Chatter	Muzaffarabad	88,153	49,153
BHU Mera Kalan	Muzaffarabad	276	367
BHU Panjgran	Patika(Naseerabad)	14,099	6,826
BHU Pattika	Patika(Naseerabad)	12,608	7,384
BHU Raheem Kot	Muzaffarabad	7,819	3,255
BHU Timi Banna	Muzaffarabad	981	1,451
BHU Upper Chatter	Muzaffarabad	332	239
BHU Saidpur	Patika(Naseerabad)	8,931	5,330
CMH	Muzaffarabad	15,750	11,267
Midland Hospital	Muzaffarabad	813	849
RHC Chattar Klass	Muzaffarabad	6,234	3,497
RHC Danna	Muzaffarabad	8,364	4,052
RHC Dhanni	Patika(Naseerabad)	7,320	4,073
RHC Gari Dupatta	Muzaffarabad	19,028	10,611
RHC Kahori	Patika(Naseerabad)	8,194	3,793
Wapda Team	Muzaffarabad	3,449	1,306
Total		313033	192246

Table 3. Overall coverage of COVID-19 vaccination in district Muzaffarabad

Data Type	Total population size	Fully vaccinated participants	Half-vaccinated participants	Non-Vaccinated participants
Primary data	750	542 (72.2%)	64 (8.6%)	144 (19.2%)
Secondary data	650,370	192246 (29.6%)	313033 (48.1%)	145091 (22.3%)

3.2. Assessment of reasons for unwillingness to take the Covid-19 vaccine

Of the total non-vaccinated 144 individuals, 35.4% agreed with the thought that there is no effect of vaccination against COVID-19. 26.4% generally opposed the vaccination process. 36.1% believed that they had sufficient immunity to fight COVID-19, while 34% of individuals believed there was no need for the vaccine if they strictly followed SOPs. 4.9% of individuals were found sick with COVID-19 at the time of vaccination. 34% of individuals believed the COVID-19 vaccine caused heart attacks and many other complications. 11.8% of individuals believed coronavirus was not dangerous to them, while 28.5% of individuals had no time to get vaccinated. Other reasons for not taking the COVID-19 vaccines described by the participants were pregnancy (13.9%), age issue (6.9%), identity card issue (1.4%), current sickness (2.1%), fear of injection (1.4%), blood pressure (1.4%), issue of COVID-19 being man-made (0.7%), and asthma (0.7%). Out of 64 half-vaccinated participants, 28 (43.7%) had no time to take a second dose, and 17 (26.6%) had fear of side effects. 6 (9.4%) participants blamed COVID-19 health care units, 4 (6.2%) participants had some issues regarding identity cards, 7 (10.9%) participants had illness after the 1st dose, 1 (1.6%) participant agreed that the COVID-19 vaccine wasn't effective, and 1 (1.6%) participant had a pregnancy after the first dose as shown in Table 4.

Table. 4 Reasons for unwillingness to take the COVID-19 vaccines

Statement	Agree	Strongly Agree	Disagree	Strongly disagree
I think the vaccine is not effective.	35(24.3%)	16(11.1%)	93(64.6%)	0
I oppose the COVID-19 vaccine in general.	25(17.4%)	13(9.0%)	106(73.6%)	0
I believe that I have sufficient natural immunity.	44(30.6%)	8(5.5%)	92(63.9%)	0
I think there is no need to get vaccinated if I strictly follow SOPs.	42(29.1%)	7(4.9%)	95(66%)	0
I had COVID-19 at the time of vaccination.	4(2.8%)	3(2.1%)	135(93.7%)	2(1.4%)
I think the COVID-19 vaccine causes heart attacks and many other complications.	22(15.3%)	27(18.7%)	92(63.9%)	3(2.1%)
I think the coronavirus is not dangerous to me.	12(8.3%)	5(3.5%)	125(86.8%)	2(1.4%)
I don't have time to get vaccination.	19(13.2%)	22(15.3%)	100(69.4%)	3(2.1%)
Others reasons for unwillingness to get the Covid-19 vaccines				
Reason	**Number Respondents**			
Pregnancy	20(13.9%)			
Age issue	10(6.9%)			
Identity card issue	2(1.4%)			
Currently sick	3(2.1%)			
Fear of injection	2(1.4%)			
Blood pressure issues	2(1.4%)			
COVID-19 is man-made	1(0.7%)			
Asthma	1(0.7%)			

3.3. Effectiveness of different Covid-19 vaccines

SinoVac was the most commonly used vaccine, taken by 265 (43.7%) individuals. Sinopharm was taken by 108 (17.8%) individuals. 103 (17%) individuals had taken Pfizer, 96 (15.8%) individuals had taken CanSino, 21 (3.5%) individuals had taken Moderna, AstraZeneca had taken 11 (1.8%) individuals, and both Sputnik V and PakVac were being taken by 1 (0.2%) individual for each. Only 23 (4.2%) of the total 542 fully vaccinated participants had COVID-19 after being vaccinated. The average time duration of getting COVID-19 after vaccination was 3.6 months. CanSino was found to be the most effective at 97.9%, Sinopharm was found to be 96.3% effective, Pfizer was found to be 96.1% effective, SinoVac was found to be 95.9% effective, and Moderna was found to be 90.5% effective. However, there was a very low number of individuals who had taken Sputnik V, AstraZeneca, and Pak-Vac, so their effectiveness percentage was negligible (Table 5).

Table 5. The status of different vaccines taken and their effectiveness

Vaccine been taken	No of participants	Infected by COVID-19 after vaccination	Vaccine effectiveness
Pfizer	103(17%)	4(3.9%)	96.1%
Moderna	21(3.5%)	2(9.5%)	90.5%
Sinopharm	108(17.8%)	4(3.7%)	96.3%
SinoVac	265(43.7%)	11(4.1%)	95.9%
CanSino	96(15.8%)	2(2.1%)	97.9%
Sputnik V	1(0.2%)	0	100%
AstraZeneca	11(1.8%)	0	100%
PakVac	1(0.2%)	0	100%

3.4. Post-vaccination side effects of Covid-19

The most frequently observed side effects were pain at the injection site in 333 individuals (55%), fever in 288 (47.5%), tiredness in 177 (29.5%), headache in 141 (23.3%), and muscle pain in 128 (21.1%). Joint pain was reported by 13.9% of individuals, while 5.4% of individuals reported nausea. 4.5% of the individuals experienced body pain. Other side effects were heart pain (1%), allergy (0.5%), suffocation (0.5%), blood pressure issues (0.3%), loss of taste (0.3%), lung pain (0.3%), stomach pain (0.2%), menstrual cycle disturbance (0.2%), loss of sense (0.2%), cough/flu (0.2%), and breathing problems (0.2%) (Table 6).

Table 6. The side effects raised in the body after the vaccination

Questions	Response in Yes	Response in No
Did you feel Fever?	288(47.5%)	318(52.5%)
Did you feel headache?	141(23.3%)	465(76.7%)
Did you feel tiredness?	177(29.2%)	429(70.8%)
Did you feel pain at injection site?	333(55%)	273(45.0%)
Did you feel muscle pain?	128(21.1%)	478(78.9%)
Did you feel joint pain?	84(13.9%)	522(86.1%)
Did you feel Nausea?	33(5.4%)	573(94.6%)
Others Effects		
Body pain	27(4.5%)	
Loss of taste	2(0.3%)	
Allergy	3(0.5%)	
Heart pain	6(1%)	
Lung’s pain	2(0.3%)	
Suffocation	3(0.5%)	
Blood pressure issue	2(0.3%)	

Stomach pain	1(0.2%)
Menstrual cycle disturbance	1(0.2%)
Loss of sense (Any of the five senses)	1(0.2%)
Cough/flu	1(0.2%)
Breathing problem	1(0.2%)

3.5. Public awareness and perception of Covid-19 vaccines

Information on the COVID-19 vaccines was assessed through a questionnaire from participants. 92.9% of individuals showed positive knowledge of COVID-19. 1.9% of people had negative attitudes towards the COVID-19, while 5.2% had no knowledge of it. 83% of individuals showed positive knowledge towards COVID-19 vaccination, 14.2% of individuals showed negative knowledge toward COVID-19 vaccination, and 2.8% of individuals had no knowledge about it. Of a total of 750 participants, 3.5% of individuals believed pharmaceutical companies created COVID-19 to get profit from vaccines. 3.9% of individuals believed some powers wanted to inject chips through vaccines to control Muslims. 0.9% of individuals were found to believe COVID-19 vaccines comprised only water. 0.8% of individuals believed they didn't need the vaccine as they already had COVID-19. 0.3% of people believed COVID-19 vaccines entered cells and changed their DNA; 2% of individuals believed that after getting the COVID-19 vaccination, they would die within 2 years; 2.1% agreed that the COVID-19 vaccine caused COVID-19; and 3.2% believed the COVID-19 vaccines affected their fertility. In the present study, 77.3% of participants showed a positive attitude on the COVID-19 vaccination. Only 2.1% of participants showed a negative attitude, whereas 20.6% of participants were not sure about the COVID-19 vaccination. However, further details of attitude and perception of participants about the COVID-19 vaccination are given in Table 7.

Table 7. The attitude/perception of the participants toward COVID-19 vaccines

Statement	**Agree**	**Disagree**	**Not sure**
Pharmaceutical companies created COVID-19 to get profit from it.	26(3.5%)	514(68.5%)	210(28%)
Some powers wanted to inject chip through vaccines to control over Muslims.	29(3.9%)	524(69.9%)	197(26.2%)
COVID-19 vaccines are comprised of only water.	7(0.9%)	636(84.8%)	107(14.3%)
I have already had COVID-19, so I don’t need a vaccine.	6(0.8%)	677(90.3%)	67(8.9%)
COVID-19 vaccines enter cells and change your DNA.	2(0.3%)	364(48.5%)	384(51.2%)
After taking vaccine, people will die within 2 years.	15(2%)	661(88.1%)	74(9.9%)
COVID-19 vaccine causes COVID-19.	16(2.1%)	629(83.9%)	105(14%)
COVID-19 vaccines affect the fertility of a person.	24(3.2%)	632(84.3%)	94(12.5%)

3.6. Union council wised correlation between sex and vaccination status

A total of 28 (93.3%) people had received the vaccine of a total of 30 participants in the UCs Maira Kalan and Ghori, which was the highest among all UCs. Similarly, the second-highest vaccinated individuals were found in the UCs Kai Manja and Sarli Sacha, with 27 (90%), and 26 (86.7%) in the UCs Bheri, Pangran, Langerpura, Saidpur, and Noora Seri. 25 (83.3%) of the vaccinated individuals were found in the UCs Machiara, Ghari, Kumikot, Danna, and Jandgran. 24 (80%) vaccinated individuals were found in the UCs Gojra, Talgran, and Katkir. The number of COVID-19 vaccinated individuals was found to be 23 (76.7%) in the UCs Charakpura and Muzaffarabad, 22 (73.3%) in the

UCs Domail and Chattar Klass, and 21 (70%) in the UCs Therian and Balgran. UC Panjkot 19 (63.3%) and UC Heerkotli 18 (60%) had the lowest percentage of people who had a COVID-19 vaccination. The Two-Tailed Chi-Square test at p 0.05 with 95% Cl was calculated to find out the correlation between sex and vaccination status. The finding confirms that there is no significant relationship between sex and vaccination status in all the UCs of district Muzaffarabad except for UC Langerpura with a p value of 0.0317 and UC Saidpur with a p value of 0.0085, in which we found a significant relationship between sex and vaccination status shown in table 8.

Table 8. UC-wise correlation between gender and vaccination status of the participants

Names of UC's	Total Participants	COVID-19 Vaccination Status	Over all Gender Distribution		Vaccinated Participants		Non vaccinated Participants		Two Tailed Chi-square Test at p<0.05 with 95% Cl		
			F	M	F	M	F	M	P Value	Odds Ratio	Relationship b/w sex and vaccination status
Charakpura	30	23(76.7%)	21	9	17	6	4	3	0.7865	0.7969	Not Significant
Therian	30	21(70%)	18	12	11	10	7	2	0.1932	0.3143	Not Significant
Balgran	30	21(70%)	12	18	6	15	6	3	0.0510	0.2000	Not Significant
Bheri	30	26(86.7%)	13	17	9	17	4	0	0.0140	0.06032	Not Significant
Machiara	30	25(83.3%)	24	6	20	5	4	1	1.0000	1.000	Not Significant
Pangran	30	26(86.7%)	13	17	10	16	3	1	0.1698	0.2083	Not Significant
Heerkotli	30	18(60%)	12	18	5	13	7	5	0.4292	0.5385	Not Significant
Kai Manja	30	27(90%)	9	21	7	20	2	1	0.1441	0.1750	Not Significant
Chattar Klass	30	22(73.3%)	9	21	5	17	4	4	0.5949	0.5882	Not Significant
Katkir	30	24(80%)	16	14	12	12	4	2	0.4642	0.5000	Not Significant
Ghari	30	25(83.3%)	14	16	10	14	4	2	0.2723	0.3571	Not Significant
Langerpura	30	26(86.7%)	15	15	11	15	4	0	0.0317	0.08244	Significant
Saidpur	30	26(86.7%)	18	12	18	8	0	4	0.0085	19.59	Significant
Panjkot	30	19(63.3%)	8	22	4	15	4	7	0.3608	0.4667	Not Significant
Sarli sacha	30	27(90%)	13	17	12	15	1	2	0.7125	1.600	Not Significant
Maira Kalan	30	28(93.3%)	13	17	11	17	2	0	0.0941	0.1314	Not Significant
Talgran	30	24(80%)	15	15	11	13	4	2	0.3613	0.4231	Not Significant
Kumikot	30	25(83.3%)	14	16	12	13	2	3	0.7434	1.385	Not Significant
Danna	30	25(83.3%)	15	15	13	12	2	3	0.6242	1.625	Not Significant
Jandgran	30	25(83.3%)	19	11	17	8	2	3	0.2356	3.188	Not Significant
Muzaffarabad	30	23(76.7%)	18	12	14	9	4	3	0.8601	1.167	Not Significant
Domail	30	22(73.3%)	19	11	14	8	5	3	0.9545	1.050	Not Significant
Noora Seri	30	26(86.7%)	19	11	16	10	3	1	0.6030	0.5333	Not Significant
Gojra	30	24(80%)	20	10	16	8	4	2	1.0000	1.000	Not Significant
Ghori	30	28(93.3%)	24	6	22	6	2	0	0.4642	0.6923	Not Significant

3.7. Multiple linear regression analysis for comparison of participants age, gender, and marital status with their Covid-19 vaccination status

For the present study, multiple linear regression with a 95% confidence interval at a p value of 0.05 for the COVID-19 vaccine status association with age, gender, and marital status was calculated through GraphPad Prism version 7.04. The analysis for the variance was calculated. The regression P value with age was found to be 0.0012, with gender was found to be 0.0361, and with marital status was found to be 0.0041. A p value <0.0001 was found for the regression analysis of COVID-19 vaccine status with age, gender, and marital status. The normality test at p value 0.05 was calculated for the above-listed variables through D'Agostino-Pearson omnibus (p<0.0001), Anderson-Darling (p<0.0001), Shapiro-Wilk (p<0.0001), and Kolmogorov-Smirnov (p<0.0001). In the present study, during the calculation of multiple linear regression, there was not a single variable that could pass the normality test (Table 9, 10, and 11).

Table 9. Multiple linear regression analysis (Regression type: Least Squares)

Dependent variable	**Have you been vaccinated against COVID-19?**				
Analysis of variance	SS	DF	MS	F (DFn, DFd)	P value
Regression	3.199	4	0.7998	F (4,745) = 5.295	P=0.0003
Age	1.604	1	1.604	F (1,745) = 10.62	P=0.0012
Gender	0.6662	1	0.6662	F (1,745) = 4.410	P=0.0361
Marital status	1.672	2	0.8360	F (2,745) =5.534	P=0.0041

Table 10. Regression results of different variables

Parameter estimates	**Variable**	**Estimate**	**Standard error**	**95% Cl (asymptotic)**	**T**	**P value**
β0	Intercept	1.263	0.07068	1.125 to 1.402	17.88	<0.0001
β1	Age	-0.003855	0.001183	-0.006178 to -0.001532	3.258	0.0012
β2	Gender	0.06018	0.02865	0.003922 to 0.1164	2.100	0.0361
β3	Marital status	-0.09754	0.03910	-0.1743 to -0.02079	2.495	0.0128

Table 11. Normality tests for the under-study variable

Normality of Residuals	**Statistics**	**P value**	**Passed normality test (alpha =0.05)?**
D' Agostino-Pearson omnibus (K2)	171.5	<0.0001	No
Anderson-Darling (A2)	137.4	<0.0001	No
Shapiro-Wilk (W)	0.6163	<0.0001	No
Kolmogorov-Smirnov (distance)	0.3525	<0.0001	No

3.8. Vaccination status of Covid-19 among different tribes

There were 750 individuals from 17 different tribes. Among 17 tribes, 162 (81.9%) of the 198 total respondents in the Rajpoot tribe had received vaccinations. Similarly, out of a total of 75 respondents from the Awan tribe, 60 (80%) had received the vaccination, and out of 73 respondents from the Chaudhary tribe, 55 (75.3%) had received the vaccination. In the Syed tribe, out of a total of 58 respondents, 48 (82.8%) had gotten the vaccine. In the Abbasi tribe, out of a total of 53 individuals, 43 (81.1%) respondents had taken the vaccine. We also found 40 (77%) vaccinated individuals in the Mughal tribe, 38 (82.6%) in the Mir tribe, 34 (89.5%) in the Khan tribe, 29 (85.3%) in the Sheikh tribe, and 15 (79%) in both the Malik and Qureshi tribes. Out of a total of 17 individuals, 12 (70.6%) of the Kiani tribe had been vaccinated. There were 17 (77.3%) vaccinated individuals in Khawaja, 7 (77.8%) in Khokhar, 6 (75%) in Dar, and 6 (85.7%) in Bhatti, and all 6 individuals were vaccinated in Minhas tribes. Some of the tribes (Magry, Masoodi, Rana, Swati, Satti, Kohan, Sudhan Turk, and Usmani) had a relatively small number of participants included collectively in the special cluster mentioned as "others," as shown in Table 12.

Table 12. This table shows the vaccination status of COVID-19 in different tribes of participants

Tribe	**No. of Individuals**	**Vaccinated Participants**	**Non-vaccinated Participants**
Rajpoot	198	162(81.9%)	36(18.1%)
Awan	75	60(80%)	15(20%)
Chaudhary	73	55(75.3%)	18(24.7%)
Syed	58	48(82.8%)	10(17.2%)
Abbasi	53	43(81.1%)	10(18.9%)
Mughal	52	40(77%)	12(23%)
Mir	46	38(82.6%)	8(17.4%)

Khan	38	34(89.5%)	4(10.5%)
Sheikh	34	29(85.3%)	5(14.7%)
Malik	19	15(79%)	4(21%)
Qureshi	19	15(79%)	4(21%)
Kiani	17	12(70.6%)	5(29.4%)
Khawaja	22	17(77.3%)	5(22.7%)
Khokhar	9	7(77.8%)	2(22.2%)
Dar	8	6(75%)	2(25%)
Bhatti	7	6(85.7%)	1(14.3%)
Minhas	6	6(100%)	0
Others (with very low populations)	16	15(93.8%)	1(6.2%)

4. DISCUSSION

To our knowledge, this is the first survey of vaccination coverage and its effectiveness in the population of the district of Muzaffarabad, Azad Jammu and Kashmir. The results of this review collected from the Expanded Programme on Immunization (EPI), show that, 29.6% of a total population of the district Muzaffarabad were fully vaccinated, while 48.1% were partially vaccinated. However, a similar study carried out by Mathieu et al. [24] reported that only 8.4% of the United Kingdom's population had taken both doses, while 46.7% had taken at least one dose.

In the United States, 19% had been fully vaccinated, and 32.9% had taken one dose. This study showed less vaccine coverage as compared to the vaccine coverage in district Muzaffarabad. 29.6% of the population were fully vaccinated, while 48.1% of the population were half vaccinated in the district Muzaffarabad. According to primary data, 72.2% of individuals were fully vaccinated, whereas 8.6% of individuals were half vaccinated. Similarly, a national cross-sectional study done in China by Miao et al. [25] shows that 89.4% of the population have had a COVID-19 vaccination. This was a broad nationwide study to analyze the status of COVID-19 vaccination coverage in 31 provinces throughout China.

Our findings show that, 92.9% of individuals had positive knowledge of COVID-19. Similar to our study, Singh et al. [26] did a survey in India and came to the conclusion that more than half of the sample population had high knowledge and a positive attitude, with proportions of 58.6% and 62.1%, respectively. The knowledge and attitude factors differ significantly depending on one's level of education. According to Ahmed et al. [27], a total of 330 participants, of which 184 girls (55.8%) and 146 males (44.2%) were enrolled in the study. Nearly all (98.8%) of the participants agreed that COVID-19 is contagious and are aware of the cause of coronavirus disease. As the most typical method of transmission, respiratory droplets (87%) were considered. Similar to findings, 95.2% of individuals believed COVID-19 spreads through respiratory droplets. 83% of individuals showed positive knowledge towards COVID-19 vaccination in district Muzaffarabad. Another research performed by Abebe et al. [28] in Ethiopia found that the percentage of people with good information, a positive attitude, and a willingness to take the COVID-19 vaccine, respectively, was 74%, 44.7%, and 62.6%. The differences in the result of studies are due to the different sizes and study population backgrounds.

In current study, SinoVac was the most commonly used vaccine, taken by 43.7% of individuals. Sinopharm was taken by 17.8% of individuals. 17% of individuals had taken Pfizer, 15.8% of individuals had taken CanSino, 3.5% of individuals had taken Moderna, AstraZeneca had taken 1.8% of individuals, and both Sputnik V and PakVac were being taken by 0.2% of individuals for each. Similarly, a study conducted by Kupek [29] in Brazil revealed that around 80% of the COVID-19 vaccination doses were Sinovac. In the present study, CanSino was found to be the most effective at 97.9%, Sinopharm was found to be 96.3% effective, Pfizer was found to be 96.1% effective, SinoVac was found to be 95.9% effective, and Moderna was found to be 90.5% effective. Richardson et al. [30] revealed in a study that the probability of COVID-19 disease was reduced by 20% by the CanSino

(Adv5-nCoV) COVID-19 vaccination, hospitalization was reduced by 76%, and death was reduced by 94%. Similar to present finding, Lin et al. [31] did research in North Carolina and reported that the mRNA vaccines BNT162b2 and mRNA-1273 were 95.9% and 94.5% effective for COVID-19, respectively.

In a study conducted on the total population of Abruzzo, Italy, Acuti-Martellucci et al. [32] found that 13.4% of the participants had SARS-CoV-2 infection, 1.1% developed severe COVID-19, and 0.6% had eventually died after being vaccinated. In another cohort analysis by Jara et al. [33], roughly 10.2 million participants were included. He reported that the estimated vaccine effectiveness among people who had received all doses was 65.9% for preventing COVID-19. While, in our study, only 4.2% of fully vaccinated participants had COVID-19 after being vaccinated because in our study, the population size was smaller, which may be the reason for the difference in the results of both studies. The most commonly observed side effects were pain at the injection site (55%), fever (47.5%), tiredness (29.2%), headache (23.3%), and muscle pain (21.1%), whereas 13.9% of individuals reported joint pain and 5.4% of individuals reported nausea. 4.5% of individuals experienced body pain. Similarly, Alhazmi et al. [34] conducted a study in Saudi Arabia and concluded that fatigue and pain, as well as redness at the injection site, were the most often observed side effects (90% and 85%, respectively). 66% of participants reported having a fever, and 62% of individuals reported headaches. But just 28% and 2% of people reported experiencing nausea, vomiting, joint pain, or bone discomfort. Another study conducted by Abbas et al. [35] in Pakistan reported that 45.4% of participants noted fatigue as a side effect following vaccination, and 39.5% noted headache. 33.7% of participants reported having a fever after receiving the vaccination, while 27.3% of individuals complained of redness, and puffiness where the injection had been given. The diverse population sizes and participant lifestyles, which have a particular impact on their immunity level, may be the cause of the difference in the findings.

In our study, 77.3% participants showed a positive attitude towards COVID-19 vaccination. A cross-sectional study did by Tahir et al. [36] in Pakistan revealed that, 66.8% of individuals had a positive view toward the COVID-19 vaccination, and 70.8% of participants would accept it. Similar findings came from a few European nations, where Neumann-Böhme et al. [37] observed that the readiness to receive the vaccination was 62% in France, 80% in Denmark, and 80% in the UK. Another research conducted by Bacong & Haro-Ramos, [38] found that at least 70% population of Californians were open to receive the COVID-19 vaccine.

Conclusions and recommendation

The cross-sectional study in Muzaffarabad district revealed positive COVID-19 knowledge (92.9%), COVID-19 vaccination knowledge (83%), and a positive attitude toward vaccination (77.3%) among the participants. In the studied population, 72.2% were fully vaccinated, with 4.2% experiencing COVID-19 post-vaccination. CanSino showed the highest effectiveness (97.9%), followed by Sinopharm (96.3%), Pfizer (96.1%), SinoVac (95.9%), and Moderna (90.5%). Common side effects included pain at the injection site (55%), fever (47.5%), tiredness (29.2%), headache (23.3%), and muscle pain (21.1%).

Despite positive attitudes, vaccination rates varied between primary and secondary data, and the participants of various union councils, potentially due to differences in population sizes. Some individuals encountered COVID-19 after vaccination, often due to missed booster doses. Advocating for timely booster administration is crucial for enhancing vaccine efficacy and ensuring sustained protection in the community. The study underscores the success of vaccination campaigns in urban areas while highlighting the need for ongoing efforts to address access challenges in rural areas and combat vaccine hesitancy. Overall, the vaccination campaign represents a positive stride toward achieving a herd immunity and tackling global COVID-19 challenges in Muzaffarabad.

DECLARATIONS

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Data Availability: Hard copies of the questionnaire (till discarding process) and the data in soft form excel sheets are available, and will be provided to the journal on a suitable demand.
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References

1. Yang L, Liu S, Liu J, Zhang Z, Wan, X, Huang B, Chen Y, Zhang Y. COVID-19: immunopathogenesis and Immunotherapeutics. Signal transduction and targeted therapy. 2020;5(1):128.
2. Lake MA. What we know so far: COVID-19 current clinical knowledge and research. Clinical Medicine. 2020;20(2):124-127.
3. World Health Organization. WHO Coronavirus (COVID-19) Dashboard. 2023. https://covid19.who.int/
4. Wen Z, Zhang Y, Lin Z, Shi K, Jiu Y. Cytoskeleton-a crucial key in host cell for coronavirus infection. Journal of Molecular Cell Biology. 2020;12(12):968-979.
5. Mittal A, Manjunath K, Ranjan RK, Kaushik S, Kumar S, Verma V. COVID-19 pandemic: Insights into structure, function, and hACE2 receptor recognition by SARS-CoV-2. PLOS PATHOGEN. 2020. https://doi.org/10.1371/journal.ppat.1008762
6. Chilamakuri R, Agarwal S. COVID-19: Characteristics and Therapeutics. Cells. 2020;10:206.

7. Hamre D, Procknow JJ. A New Virus Isolated from the Human Respiratory Tract. Experimental Biology and Medicine. 1966;121(1):190-193.
8. McIntosh K, Dees JH, Becker WB, Kapikian AZ, Chanock RM. Recovery in tracheal organ cultures of novel viruses from patients with respiratory disease. Proceedings of the National Academy of Sciences of the United States of America. 1667;57(4): 933-940.
9. Forni G, Mantovani A. COVID-19 vaccines: where we stand and challenges ahead. Cell Death & Differentiation. 2021;28(2):626-639.
10. Cevik M, Grubaugh ND, Iwasaki A, Openshaw P. COVID-19 vaccines: Keeping pace with SARS-CoV-2 variants. Cell. 2021;184(20):5077-5081.
11. Privor-Dumm L, Excler JL, Gilbert S, Karim SSA, Hotez, PJ, Thompson D, Kim JH. Vaccine access, equity and justice: COVID-19 vaccines and vaccination. BMJ Global Health. 2023;8(6):e011881.
12. World Health Organization. Status of COVID-19 Vaccines within WHO EUL/PQ Evaluation Process 2021. 2021. https://extranet.who.int/pqweb/key-resources/documents/status-covid-19-vaccines-within-who-eulpq-evaluation-process
13. Creech CB, Walker SC, Samuels RJ. SARS-CoV-2 vaccines. Jama. 2021;325(13):1318-1320.
14. Zheng C, Shao W, Chen X, Zhang B, Wang G, Zhang W. Real-world effectiveness of COVID-19 vaccines: a literature review and meta-analysis. International Journal of Infectious Diseases. 2022;114:252-260.
15. Palacios R, Patiño EG, Piorelli RDO, Conde MTRP, Batista AP, Zeng G, Xin Q, Kallas EG, Flores J, Ockenhouse CF, Gast C. Double-Blind, Randomized, Placebo-Controlled Phase III Clinical Trial to Evaluate the Efficacy and Safety of treating Healthcare Professionals with the Adsorbed COVID-19 (Inactivated) Vaccine Manufactured by Sinovac–PROFISCOV: A structured summary of a study protocol for a randomised controlled trial. Trials. 2020;21(1):1-3.
16. Nogrady B. Mounting evidence suggests Sputnik COVID vaccine is safe and effective. Nature. 2021;595(7867):339-340.
17. Mousa M, Albreiki M, Alshehhi F, AlShamsi S, Al Marzouqi N, Alawadi T, Alrand H, Alsafar, H, Fikri A. Similar effectiveness of the inactivated vaccine BBIBP-CorV (Sinopharm) and the mRNA vaccine BNT162b2 (Pfizer-BioNTech) against COVID-19 related hospitalizations during the Delta outbreak in the UAE. Journal of Travel Medicine. 2022. https://doi.org/10.1093/jtm/taac036
18. World Health Organization. Evidence Assessment: Sinopharm/BBIBP COVID-19 Vaccine. 2021. https://cdn.who.int/media/docs/defaultsource/immunization/sage/2021/april/2_sage29apr2021_critical-evidence_sinopharm.pdf
19. AlHosani FI, Stanciole AE, Aden B, Timoshkin A, Najim O, Zaher WA, AlDhaheri FA, Al Mazrouie S, Rizvi TA, Mustafa F. Impact of the Sinopharm's BBIBP-CorV vaccine in preventing hospital admissions and death in infected vaccinees: Results from a retrospective study in the emirate of Abu Dhabi, United Arab Emirates (UAE). Vaccine. 2022;40(13):2003-2010.
20. Paixao ES, Wong KL, Alves FJO, de Araújo Oliveira V, Cerqueira-Silva T, Júnior JB, Machado TM, Junior EPP, Boaventura VS, Penna GO, Werneck GL, Rodrigues LC, Pearce N, Barreto ML, Barral-Netto M. CoronaVac vaccine is effective in preventing symptomatic and severe COVID-19 in pregnant women in Brazil: a test-negative case-control study. BMC medicine. 2022;20(1):1-8.
21. Nisar MI, Ansari N, Malik AA, Ramzan Ali Lalani K, Chandna MA, Younus AM, Hasan Z, Khan U, Khalid F, Mahesar M, Omer SB. Assessing the Effectiveness of COVID-19 Vaccines in Pakistan: A Test-Negative Case-Control Study. Preprints with The Lancet. 2022. http://dx.doi.org/10.2139/ssrn.4112153
22. Hayat M, Uzair M, Ali Syed R, Arshad M, Bashir S. Status of COVID-19 vaccination around South Asia. Human Vaccines & Immunotherapeutics. 2022;18(1):2016010.

23. World Health Organization. WHO Coronavirus (COVID-19) Dashboard. 2023. https://data.who.int/dashboards/covid19/cases?n=c
24. Mathieu E, Ritchie H, Ortiz-Ospina E, Roser M, Hasell J, Appel C, Giattino C, Rodés-Guirao L. A global database of COVID-19 vaccinations. Nature human behaviour. 2021;5(7):947-953.
25. Miao Y, Zhang W, Li Y, Wu J, Xu D, Gu J, Wang M, Wei W, Ye B, Miao C, Tarimo CS, Dong, W. Association between lifestyle and COVID-19 vaccination: a national cross-sectional study. Frontiers in Public Health. 2022;10:918743.
26. Singh PK, Anvikar A, Sinha A. COVID-19 related knowledge, attitudes, and practices in Indian Population: An online national cross-sectional survey. PloS one. 2022;17(3):e0264752.
27. Ahmed N, Hassan W, Rasool R, Fahim U, Shakil A, Khan KS. Knowledge, attitude and practices regarding COVID-19 among a cross-sectional sample from Karachi, Pakistan: descriptive data. Journal of Infectious Diseases and Epidemiology. 2020;6(5):164.
28. Abebe H, Shitu S, Mose A. Understanding of COVID-19 vaccine knowledge, attitude, acceptance, and determinates of COVID-19 vaccine acceptance among adult population in Ethiopia. Infection and drug resistance. 2021;14: 2015.
29. Kupek E. Low COVID-19 vaccination coverage and high COVID-19 mortality rates in Brazilian elderly. Revista Brasileira de Epidemiologia. 2021.
30. Richardson VL, Franco MAC, Márquez AB, Valdez LM, Ceronio LEC, Cruz VC, Gharpure R, Lafond KE, Yau TS, Azziz-Baumgartner E, Ávila MH. Vaccine effectiveness of CanSino (Adv5-nCoV) COVID-19 vaccine among childcare workers–Mexico, March–December 2021. Cold Spring Harbor Laboratory BMJ Yale. 2022.
31. Lin DY, Gu Y, Wheeler B, Young H, Holloway S, Sunny SK, Moore Z, Zeng D. Effectiveness of Covid-19 vaccines over a 9-month period in North Carolina. New England Journal of Medicine. 2022;386(10):933-941.
32. Acuti Martellucci C, Flacco ME, Soldato G, Di Martino G, Carota R, Caponetti A, Manzoli L. Effectiveness of COVID-19 Vaccines in the General Population of an Italian Region before and during the Omicron Wave. Vaccines. 2022;10(5):662.
33. Jara A, Undurraga EA, González C, Paredes F, Fontecilla T, Jara G, Pizarro A, Acevedo J, Leo K, Leon F, Sans C, Leighton P, Suárez P, García-Escorza H, Araos R. Effectiveness of an inactivated SARS-CoV-2 vaccine in Chile. New England Journal of Medicine. 2021;385(10):875-884.
34. Alhazmi A, Alamer E, Daws D, Hakami M, Darraj M, Abdelwahab S, Maghfuri A, Algaissi A. Evaluation of side effects associated with COVID-19 vaccines in Saudi Arabia. Vaccines. 2021;9(6):674.
35. Abbas S, Abbas B, Amir S,Wajahat M. Evaluation of adverse effects with COVID-19 vaccination in Pakistan. Pakistan Journal of Medical Sciences. 2021;37(7):1959.
36. Tahir MJ, Saqlain M, Tariq W, Waheed S, Tan SH, Nasir SI, Ullah I, Ahmed A. Population preferences and attitudes towards COVID-19 vaccination: a cross-sectional study from Pakistan. BMC public health. 2021;21(1):1-12.
37. Neumann-Böhme S, Varghese NE, Sabat I, Barros PP, Brouwer W, van Exel J, Schreyögg J, Stargardt T. Once we have it, will we use it? A European survey on willingness to be vaccinated against COVID-19. The European Journal of Health Economics. 2020;21(7):977-982.
38. Bacong AM, Haro-Ramos AY. Willingness to receive the COVID-19 vaccine in California: disparities by race and citizenship status. Journal of Racial and Ethnic Health Disparities. 2023;10(6):2911-2920.