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Understanding COVID-19 vaccine hesitancy in Pakistan: The paradigm of confidence, convenience, and complacency; A cross-sectional study

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Abstract

Background and objectives

Vaccine hesitancy is a big obstacle for vaccination programs, as is anticipated for the COVID-19 vaccination program, resulting in low uptake of vaccines thereby hindering the process of reaching herd immunity. Bearing this in mind the current study was aimed to explore the determinants of vaccine hesitancy amongst the Pakistani population.

Methodology

A cross-sectional study was carried out from November 2020 to March 2021. The conceptual framework of the study was based on the 3Cs (Confidence, Convenience, Complacency) model. The google-forms-based questionnaire was disseminated amongst the general population. Data collected were entered into SPSS version 26 and analyzed.

Results

Of the 421 participants, 68.4% were women. Non-healthcare workers were 55.8% of respondents. Of vaccine-hesitant individuals, 26.13% reported they were very unlikely to get vaccinated. Perception of COVID-19 vaccine was explored, which revealed 12.6% of individuals agreed the vaccine was not safe as it came out too fast, 50.6% were worried about experiencing side-effects, 18% believed the vaccine will not offer protection and 5.9% believed the vaccine would cause death. Low Practice of standard operating procedure (SOP) in non-Healthcare workers was the strongest contributor to vaccine hesitancy (OR: 5.338, p = 0.040, 95% CI: 1.082–26.330) followed by High complacency (p = 0.026) and Moderate Complacency (OR: 0.212, p = 0.007, 95% CI: 0.069–0.654) towards COVID-19 vaccination. In Healthcare workers the strongest contributor to vaccine hesitancy was having a Moderate Confidence (OR: 0.323, p = 0.042, 95% CI: 0.109–0.958) in the vaccine followed by Moderate Convenience (OR: 0.304, p = 0.049, 95% CI: 0.093–0.993) for vaccination.

Conclusion

Campaigning and communication strategies to reaffirm confidence in the COVID-19 vaccine and educating the general population about the vaccine could lead to increased perception of vaccine safety and effectiveness thereby restoring confidence in vaccine and decreasing vaccine hesitancy. Likewise, working to increase vaccine convenience and decreasing complacency towards the COVID-19 vaccine would translate into high vaccine uptake.

MeSH words

Vaccine hesitancy; vaccination intention, COVID-19 vaccine, vaccine confidence, complacency, convenience.

Introduction

'Vaccine hesitancy refers to delayed acceptance or refusal of vaccination, despite resource availability [1]. This well-known phenomenon endorsed into the present day is as old as the vaccine themselves [2], dating back to resistance programs against the mandated smallpox vaccination initiative in the mid-1800s [3]. Consequently, over the years due to this phenomenon, vaccine-preventable diseases (VPD) the likes of measles, pneumococcal disease, pertussis, and poliomyelitis have resurfaced [4]. The most serious instance of this was cited in the 2003–04 Northern Nigeria boycott of the polio vaccine, which led to the incidence of newer cases in the country [5].

A year has elapsed since the index case of the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was reported [6]. On 31st January 2020, World Health Organisation (WHO) declared a global health emergency and the coronavirus disease 2019 (Covid-19) was labeled a pandemic on 11th March 2020 [7]. Since then, as of 26th January 2021, there have been 99 million cases of infection [8], 2.1 million deaths [9], and an economic loss of $3.7 trillion in earnings to workers around the world due to COVID-19 [10].

The ongoing pandemic can be mitigated by an essential tool, an efficacious vaccine(s), which can reduce disease incidence, prevalence, new hospitalizations, and intensive care demand [11]. The Pfizer-BioNTech's (BNT162b2) and Moderna (mRNA-1273) mRNA vaccines were approved for emergency use by WHO in December 2020, giving hope for the resumption of normalcy [12]. Experts estimated that herd immunity would be achieved if 70% of the population is immune to COVID-19 [13]. However, vaccine hesitancy amongst the general public can be a significant roadblock towards ensuring adequate vaccination uptake and achieving herd immunity. Vaccine hesitancy is becoming an impediment towards VPD prevention strategies, similar is anticipated for the SARS-CoV-2 vaccine [14] and future vaccination campaigns, consequently curbing infectious disease outbreaks would become difficult with resistance to prospective vaccination programs.

Vaccine hesitancy is attributable to the '3Cs' model which comprises confidence, complacency, and convenience [15]. A lack of confidence in the vaccine safety, efficacy, or its delivery system; complacency due to a perceived low risk from VPD and vaccine inconvenience due to an inability to afford, hampers the success of vaccination campaigns [16]. Further evaluation of the vaccine hesitancy reveals that public approval of vaccination is not motivated by empirical evidence-based medicine or economic data alone, but is rather driven by a combination of complex variables like political, psychological, technical, and sociocultural, all of which must

be recognized and taken into consideration by policymakers and decision-makers [17]. In addition, conspiracy beliefs result in vaccine hesitancy by undermining the trust in government bodies, healthcare workers, and pharmaceutical industries despite knowing their negative implications on human health behavior [18, 19]. Skepticism around the vaccines being adequately tested for safety, coming out too fast, and being registered in less than a year perpetuated the social media, thereby mediating low acceptance of the potential vaccine [20]. Beliefs like vaccine causes infertility and is a means to stop population growth, is designed for electronic tattooing or microchipping individuals to achieve global surveillance and falsely asserting that vaccine causes autism, eventually lead to low vaccine uptake by the general population by undermining public confidence in vaccines and negatively impacting their attitude towards vaccination [21].

Public confidence and trust in vaccinations are highly variable. Building a group's trust in vaccines requires that one understands their perception of vaccine and vaccine-associated risks or side effects, their socioeconomic standing, political stance, and religious affiliation. Although providing factually precise, accurate, scientifically sound evidence on the risk-benefit ratios of vaccines is of paramount importance, it is not sufficient to bridge the gap between present levels of confidence afforded by the public to vaccines and levels of trust required to ensure sufficient and continued vaccine coverage [4]. In light of all this, the present study was planned to evaluate the determinants of COVID-19 vaccine hesitancy amongst the general Pakistani population. To also gauge their Willingness-to-pay (WTP) [22], thereby, ascertaining the amount they are inclined to allocate to vaccine technology.

Methodology

A cross-sectional study was conducted from November 2020 to March 2021. Participants for the study were recruited from 23rd January to 31st January 2021 through the convenience sampling technique. Research questionnaire **S1 Appendix** constructed on google-forms was disseminated via online platforms (Facebook, WhatsApp, and Gmail) amongst the general population. Inclusion criteria were individuals above the age of 18 and residents of Pakistan. Exclusion criteria were minors and individuals residing outside of Pakistan. Items in the questionnaire were based on previous literature [23]; some were modified taking into account the general population of the country. Informed electronic consent was the first part of the questionnaire. Participants were explained the voluntary nature of their participation, thereafter their consent was sought prior to filling out the questionnaire and collecting data (https://doi.org/10.6084/m9.figshare.14814882). The research was approved by the Institutional Review Board of CMH Lahore Medical College and Institute of Dentistry (Case#539/ERC/CMH/LMC).

Sample size was calculated to be 385 using the formula:

$$n = N*X/(X + N - 1),$$

where,

$$X = Z_{\alpha/2}{}^2 * p * (1 - p)/MOE^2$$

$Z_{\alpha/2}$ = critical value of the Normal distribution at α/2 (confidence level 95%, α = 0.05 and the critical value is 1.96)

MOE = margin of error = 5%

p = sample proportion = 50%

N = population size = 220 million for Pakistan.

The questionnaire comprised of four parts; demographics, a knowledge scale, and 2 sections exploring the beliefs, myths, and attitudes towards the COVID-19 vaccine and alternate preventive measures.

The Socio-demographic section recorded their gender, age group, education status, marital status, employment status, healthcare worker status, chronic disease status, and disease type.

The Knowledge scale comprised of 10 questions. This tool had yes/no/I am not sure and multiple-choice questions. 'Yes' was scored as 1 point, 'No' and 'I am not sure' were scored 0 points. Those with multiple choice answers had a correct answer scored at 1 and incorrect answers scored at 0. Two Likert scale items (5 point Likert scale), i.e vaccine can be given to pregnant/breast-feeding women and children, were also employed. The tool included questions, about knowledge of vaccine existence, government's initial plan of vaccination, re-infection, vaccination helping decrease spread of coronavirus infection, dose count, vaccine effectiveness, and route of administration, framed in an approach similar to previous studies [23–26]. The lowest possible score on the knowledge scale was 2 and the highest possible score was 18.

A separate scale to explore the perceptions of respondents, on a series of items about COVID-19 infection (n = 4), a potential COVID-19 vaccination (n = 30), and COVID-19 vaccination cost (n = 2) to establish the Willingness-To-pay, was used. These questionnaire items were computed to form 4 scales of Confidence, Convenience, Complacency (i.e 3C indicator), and SOP Practice as shown in **Table 2**. Vaccine hesitancy (intent to not vaccinate) can be attributed to these scales, where high scores on the confidence, convenience, and SOP indicator translates into low vaccine hesitancy and a high score on complacency indicator translates into high vaccine hesitancy. Respondents rated the perception statements on a five-point Likert scale (1–5) from "strongly disagree" to "strongly agree". Statements employed in the tool measured the theoretical constructs such as imagining themselves as being in a high-risk group, advantages of a potential COVID-19 vaccine, subjective norms, factors influencing their decision to vaccinate, behavioral control, myths, and beliefs about the vaccine, confidence in the Government and religious heads [23]. These statements also probed respondents' views on the vaccine enabling life to return to "normal," and them being expected to adhere to the protocol for social distancing and other limitations for COVID-19 once vaccinated, along with items gauging their acknowledgment and practice of other preventive measures. Respondents were also inquired if they would vaccinate if their employer seeks proof of vaccination or they needed the proof for travel [23]. Six statements were used to evaluate the SOP practice of participants i.e regular use of masks, taking measures such as avoiding going to crowded places during the pandemic, avoiding handshakes and physical contact during the pandemic, self-isolation if the participant or someone in their family developed fever and cough in the past few months, avoiding social gathering if the participant had flu-like symptoms and following guidelines issued by WHO and health authorities pertaining to the pandemic. The mean scores were calculated and categorized on basis of the three percentiles i.e 33^{rd}, 66^{th}, 100^{th} percentile. The three groups were Low (below the 33^{rd} percentile), Moderate (between the 34^{th} and 66^{th} percentile), and High (above the 67^{th} percentile). A few items, i.e coronavirus infection is like any other common cold, the coronavirus infection is just a media hype, individuals who are healthy or have been previously infected do not need the vaccination, if an individual has been vaccinated they do not need to social distance or follow SOPs, the vaccine will cause autism, infertility, autoimmune diseases, allergic reactions, death and will cause a coronavirus infection in the vaccinated individual upon vaccination, were calculated in the inverted sense to remain consistent with the direction of the indicator. Similarly, the vaccine was not safe as it came out too fast, and that the vaccine is more dangerous than the virus itself was also calculated in the inverted sense.

Finally, vaccination intention was also inquired ('Yes'-intends to get vaccinated and 'No'-does not intend to get vaccinated). The dichotomized response was used in the binary logistic regression model as the dependent variable with the independent/predictor variables i.e demographics, Confidence, Convenience, Complacency, and SOP scales to explore the predictors of vaccine hesitancy. The data collected was analyzed using Statistical Package for the Social Sciences (SPSS) version 26. Data were analyzed for descriptive statistic analysis (means, standard deviations, frequency, and percentages) and inferential analysis (Independent sample *t*-test & Binary logistic regression). The inferential statistics were performed to compare HCW to Non-HCW. p-value ≤ 0.05 was considered statistically significant.

Results

The questionnaire was disseminated to 427 participants, out of which 421 completed it (98.5% response rate) by agreeing to the informed consent at the start of the questionnaire. Form for six participants was closed and submitted without being filled as they clicked disagree to the consent to fill. Women were 68.4% and men were 31.6%. The age group 20–30 years had the highest amount of respondents 70.3%. Of the 421 participants, 55.8% were not health care workers (HCW; doctors, nurses, technicians, paramedics, etc) while 44.2% were HCW. **Table 1** reflects the socio-demographic features of the respondents.

Descriptive statistics for the items on the questionnaire are mentioned in **Table 2**. It also highlights how the 3C indicator was constructed. Statements other than the ones mentioned in the table used in the construction of the 3C indicator were the government's initial plan for vaccination and vaccine effectivity in Confidence indicator; the existence of a vaccine, the vaccination being an almost pain-free procedure, the vaccine being able to decrease the spread of infection and whether a person could be re-infected with COVID-19 in Complacency indicator; and route of administration along with vaccine being dose-based in the Convenience indicator.

Statements gauging the beliefs of people regarding the vaccine revealed that 14% agreed that if they were healthy or previously infected then they do not need the vaccination, 20% were in agreement that there is no need for social distancing once vaccinated, 18% believed that the vaccine will not offer them protection, 28.8% concurred that vaccination will cause allergic reactions, 12.6% believed that the vaccine is not safe as it came out too fast and 45% disagreed that the vaccine could be given to pregnant/breastfeeding women. Fear of experiencing side-effects had 50.6% agreeing to the statement. What was worrisome was that a staggering 24% disagreed that they would not vaccinate if they were in a high-risk group and 20% were in disagreement of vaccinating even if they lived with someone in a high-risk group. Even if they were a care provider, 21.7% chose to disagree with vaccinating. Despite all this, 73% did however assented that the decision to vaccinate will benefit the community. When asked if they were aware that the state had an initial vaccination strategy for the population at high risk, healthcare workers, public health workers, and people with chronic diseases, only 58.7% of the non-healthcare workers (non-HCW) responded with a 'Yes' while 81.7% of the healthcare workers (HCW) responded with a 'Yes' (p-value 0.00). When asked about the dose count of the vaccine only 49.5% of the HCW responded correctly with 2 doses while only 34.0% of the non-HCW were aware of the correct response (p-value 0.001).

Two statements in the questionnaire evaluated the Willingness-to-pay of the respondents. The first was who should cover the cost of the vaccine, and the second being that if you were to pay from pocket then how much are you willing to pay. The vaccine should be provided free of cost had 61.3% of the respondents choosing it, 28.7% chose that the vaccine be provided at a subsidized rate by the government while only 10% were willing to pay from pocket for the

Table 1. Socio-demographic details of participants (N = 421).

Demographic Variables	Frequency (%)	
Gender	Males	133 (31.6)
	Females	288 (68.4)
Age (years)	Less than 20	34 (8.1)
	20–30	296 (70.3)
	30–40	39 (9.3)
	More than 40	52 (12.4)
Education Status	Less than matric	7 (1.7)
	Matric or equivalent	8 (1.9)
	Intermediate or equivalent	15 (12.1)
	Bachelor's	256 (60.8)
	Master's	91 (21.6)
	PhD	8 (1.9)
Chronic disease status	No	358 (85)
	Yes	63 (13)
Disease type	Diabetes Mellitus	18 (4.3)
	Hypertension	27 (6.4)
	Ischemic heart disease	4 (1.0)
	Asthma	17 (4.0)
	Disease other than mentioned	12 (2.9)
Health care worker	No	235 (55.8)
	Yes	186 (44.2)
Marital Status	Single	301 (71.5)
	Married	112 (26.6)
	Divorced	3 (0.7)
	Widow	5 (1.2)
Employment Status	Student	222 (52.7)
	Full-time Job	108 (25.7)
	Part-time Job	12 (2.9)
	Self-employed	22 (5.2)
	Unemployed	19 (4.5)
	Stay at home parent	26 (6.2)
	Do not want to say	12 (2.9)

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vaccine. On the amount of money that they were willing to pay, 27.3% chose less than 500 Pak rupees (PKR)($3.16), 31.8% chose 500–1000 PKR($3.16–6.32), 23% chose 1000–2000 PKR ($6.32–12.64) while 17.8% were willing to pay more than 2000 PKR(>$12.64) for the COVID-19 vaccine. Inquiry about vaccination intention revealed, of all the participants, 73.87% reported they were likely to get vaccinated, 26.13% were unlikely to get vaccinated.

Scores were calculated for each scale and were then categorized into Low, Moderate, and High on a percentile basis. High scores on the Confidence and Convenience indicator translate into low vaccine hesitancy while high scores on the Complacency indicator translate into a high vaccine hesitancy. An independent sample t-test was performed to see if the difference in means between healthcare workers and non-healthcare workers was true or due to chance. Results are tabulated in **Table 3** (also highlighting the percentage of respondents who scored in each category). The difference was significant in Knowledge and Confidence while non-significant for the remainder indicators.

Table 2. Descriptive statistics of continuous variables evaluating confidence, complacency, convenience, practice of SOPS, and vaccination intention for COVID-19. Data are mean (standard deviation) on a 1–5 numerical rating scale (1 = strongly disagree, 5 = strongly agree).

	Item		Mean (SD)
Confidence	I would be worried about experiencing the side effects from a coronavirus vaccination		3.49 (1.26)
	The vaccine will protect me from the coronavirus infection		3.59 (1.16)
	The vaccine can be given to pregnant and breastfeeding women		2.59 (1.19)
	The vaccine will allow us to return to normal		3.35 (1.20)
	The vaccine will cause infertility		1.94 (0.98)
	The vaccine will cause autism		1.88 (0.91)
	The vaccine will cause autoimmune diseases		2.03 (1.00)
	The vaccine will cause allergic reactions		2.90 (1.07)
	The vaccine will give me a coronavirus infection if I vaccinate		1.85 (1.00)
	The vaccine will cause death		1.73 (0.97)
	The vaccine is more dangerous than the virus		1.61 (0.97)
	The vaccine is not safe as it came out too fast		2.10 (1.10)
	The vaccine is only for old and vulnerable people		1.89 (1.10)
	The vaccine can be given to children		3.19 (1.23)
	I feel I know enough about the vaccine to make an informed decision about getting vaccinated		3.60 (1.17)
Convenience	My decision to vaccinate against COVID-19 increase only if:	If it is recommended by government officials	3.12 (1.31)
		If my family vaccinates and expresses support for the benefit of the vaccine	3.18 (1.28)
		If government officials vaccinate themselves	3.09 (1.27)
		If it is recommended by a healthcare professional	3.72 (1.25)
		If it is recommended to me by a religious head of my faith	2.32 (1.25)
		If my friends vaccinate and express support for the benefit of the vaccine	2.96 (1.31)
	I will vaccinate if:	I have to show proof of vaccination to my employer	3.04 (1.36)
		I have to show proof of vaccination for travel	3.44 (1.33)
		I am in a high-risk group	3.56 (1.39)
		I live with someone who is in a high-risk group	3.66 (1.33)
		I am a care provider	3.66 (1.39)
		My decision to vaccinate benefits the community	4.03 (1.11)
Complacency	I do not consider coronavirus to be a serious issue/ It is just like any other common cold		1.66 (1.05)
	The coronavirus infection is just a media hype		1.58 (0.99)
	If I already had the infection or I am healthy then I do not need the vaccination		2.08 (1.26)
	If I were vaccinated, then I do not need to follow social distancing and other coronavirus restrictions		2.25 (1.26)
	Even if I vaccinate, I can still get infected with the coronavirus infection		2.99 (1.13)
	Practice and acknowledgment of other preventive measures (SOPs)	Been wearing a mask regularly	4.17 (1.05)
		Taken measures such as avoiding going to crowded places	3.91 (1.10)
		Avoided handshakes and physical contact in this pandemic	3.76 (1.15)
		Isolated yourself if you or someone in your family developed fever and cough in the past few months	3.92 (1.16)
		Avoided social gathering if you had flu-like symptoms	3.99 (1.15)
		Followed guidelines issued by WHO and health authorities	3.99 (1.04)
Vaccination Intention	When the coronavirus vaccine is made available in the country will you vaccinate?		4.12 (1.07)

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Mean scores of the respondents for each scale were calculated along with standard deviations and a t-test was performed to see if the difference in mean between HCW and Non-HCW was true or due to chance, the results are highlighted in the S1 Table, showing that the difference in means of Knowledge and Confidence indicator was significant between the two.

Table 3. Independent Sample t-test for knowledge, confidence, convenience, complacency, and SOP practice between Healthcare Workers (HCW) and non-health-care workers along with Score categorization for respective scales.

Category		Knowledge		Confidence		Convenience		Complacency		SOP Practice		
HCW Status		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	
Score categories	Low	37.1	44.3	26.3	39.1	34.4	37.4	31.7	36.2	33.3	34.0	%
	Moderate	38.2	34.5	35.5	34.9	29.0	31.9	37.1	40.0	37.6	36.2	%
	High	24.7	21.3	38.2	26.0	36.6	30.6	31.2	23.8	29.0	29.8	%
t value		3.049		2.806		0.627		1.382		0.249		
p- value		0.002*		0.005*		0.531		0.168		0.804		

HCW = Healthcare worker

% = percentage of individuals who got the respective score category

SOP = standard operating procedures for infection prevention

t = Student's T-Test value (Independent sample T-Test)

*p-value $\leq$ 0.05 is considered statistically significant

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A binary logistic regression analysis was performed to assess the relationship between Demographics, Knowledge, 3Cs indicator, SOP practice, and HCW status as predictors for vaccine hesitancy among the two groups. The model explained between 19.0% (Cox & Snell R square) and 28.2% (Nagelkerke R square) of the variance in Vaccine Hesitancy among HCW and between 16.3% (Cox & Snell R square) and 23.7% (Nagelkerke R square) for non-HCW. It correctly classified 76.3% of cases for HCW and 75.3% of cases for non-HCW. Table 4 shows how each component made a statistically significant contribution to the model. Predicted probabilities were for membership of 'not vaccinating'. Demographics were not a significant

Table 4. Binary logistic regression analysis predicting the likelihood of vaccine hesitancy amongst the respondents.

		Healthcare workers (n = 189)					Non-healthcare workers (n = 232)				
Predictors		B	S.E.	Wald	Sig.	OR(95% CI)	B	S.E.	Wald	Sig.	OR(95%CI)
Gender (Reference male)		0.298	0.528	0.319	0.572	1.348 (0.479–3.795)	-0.296	0.431	0.471	0.492	0.744 (0.319–1.732)
Age group 20–30 years (Reference age >40 years)		1.153	1.306	0.780	0.377	3.168 (0.245–40.975)	-0.532	0.912	0.340	0.560	0.588 (0.098–3.511)
Knowledge	Low	-0.571	0.646	0.780	0.377	0.565 (0.159–2.006)	-0.697	0.506	1.896	1.669	0.498 (0.185–1.343)
	Moderate	0.453	0.577	0.618	0.432	1.573 (0.508–4.872)	-0.470	0.473	0.986	0.321	0.625 (0.248–1.580)
	High (Reference)	-	-	4.307	0.116	-	-	-	1.921	0.383	-
Confidence	Low	-0.225	0.582	0.150	0.699	0.798 (0.255–2.497)	0.350	0.519	0.455	0.500	1.420 (0.513–3.930)
	Moderate	-1.132	0.555	4.150	**0.042***	0.323 (0.109–0.958)	0.003	0.490	0.000	0.994	1.004 (0.384–2.623)
	High (Reference)	-	-	4.352	0.114	-	-	-	0.759	0.684	-
Convenience	Low	-0.310	0.544	0.325	0.569	0.733 (0.253–2.128)	0.030	0.447	0.004	0.947	1.030 (0.429–2.475)
	Moderate	-1.190	0.604	3.889	**0.049***	0.304 (0.093–0.993)	-0.186	0.481	0.150	0.699	0.830 (0.324–2.130)
	High (Reference)	-	-	3.997	0.136	-	-	-	0.244	0.885	-
Complacency	Low	0.327	0.983	0.110	0.740	1.386 (0.202–9.509)	-1.313	0.856	2.350	0.125	0.269 (0.050–1.441)
	Moderate	-0.335	0.620	0.292	0.589	0.715 (0.212–2.413)	-1.553	0.575	7.279	**0.007***	0.212 (0.069–0.654)
	High (Reference)	-	-	0.911	0.634	-	-	-	7.303	**0.026***	-
SOP Practice	Low	0.179	0.923	0.038	0.846	1.196 (0.196–7.298)	1.675	0.814	4.231	**0.040***	5.338 (1.082–26.330)
	Moderate	0.198	0.597	0.109	0.741	1.218 (0.378–3.925)	0.498	0.569	0.765	0.382	1.645 (0.539–5.020)
	High (Reference)	-	-	0.110	0.947	-	-	-	4.362	0.113	-

B, coefficient for the constant; S.E., standard error around the coefficient for the constant; Wald, Wald chi-square test; Sig, significance (*significant if p<0.05); OR, Odds Ratio; CI, Confidence interval (95%).

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contributor to vaccine hesitancy in the model. Low Practice of SOP in non-HCW was the strongest contributor to vaccine hesitancy (OR: 5.338, p = 0.040, 95% CI: 1.082–26.330) followed by High complacency (p = 0.026) and Moderate Complacency (OR: 0.212, p = 0.007, 95% CI: 0.069–0.654) towards COVID-19 vaccination. In HCW the strongest contributor to vaccine hesitancy was having a Moderate Confidence (OR: 0.323, p = 0.042, 95% CI: 0.109–0.958) in the vaccine followed by Moderate Convenience (OR: 0.304, p = 0.049, 95% CI: 0.093–0.993) for vaccination.

Discussion

Vaccine hesitancy has a great role to play in the success of a vaccination program [27, 28]. Identifying the reasons for hesitancy and addressing them properly can help curb vaccine hesitancy thereby leading to the high uptake of vaccines and consequently reaching herd immunity faster. Our study found that 73.8% of participants were willing to get vaccinated, which is significantly higher than the figure of 62.0% reported by another study done in Pakistan [29]. The study revealed that 50.6% of respondents were worried about experiencing side-effects from the vaccine, a contributor to vaccine hesitancy, these findings are in resonance with a study published by the Centre for Economic Research in Pakistan (CERP) which reported that 54% of respondents to their study from Pakistan were worried about the safety of the vaccine [30]. When compared to the study conducted in the United States of America which reported the count of individuals worried about the safety of the vaccine to be at 63.47%, our figures of 50.6% from Pakistan are significantly lower than theirs [31]. Beliefs like vaccine will cause infertility (5.8% agreed), autism (3.1% agreed), autoimmune diseases (6.9% agreed), allergic reactions (28.8% agreed), death (5.9% agreed), is not safe as it came out too fast (12.6% agreed) and the vaccine is more dangerous than the virus (5% agreed) are unsurprising, they contributed to vaccine hesitancy and have been documented in previous literature [32–34]. Such concerns need to be addressed by the health officials (physicians, public health workers) by having a healthy dialogue with the vaccine-hesitant people. A study done in Pakistan reported that 12% of participants believed that the COVID-19 vaccine would cause infertility, this finding is significantly higher than our findings of 5.8%. This study also explored the willingness-to-pay (WTP) of the participants for the vaccine and 52.7% of participants concurred that the vaccine should cost less than <500PKR (3.12USD) which is in disagreement with our findings of 27.3% supporting this amount [35]. The exploration of willingness-to-pay for the COVID-19 vaccine helps the government and relevant public health departments to plan and manage the budgets of future vaccination programs by understanding the general public's motivation to pay for future vaccine roll-outs.

Of the respondents, 45% believed that the vaccine can not be given to pregnant/breastfeeding women, highlighting a lack of knowledge about the vaccine as The American College of Obstetricians and Gynaecologists(ACOG) recommends the vaccine for this group in guidelines with the *Advisory Committee on Immunization Practices* (*ACIP*) [36]. Our research found that 61.7% of respondents agreed that they would vaccinate on the recommendation of a healthcare worker so having better physician recommendations is a good intervention to accentuate the success of an immunization program as also cited in previous literature [37] this figure is significantly higher than 44% reported by another study done in Pakistan. The study also found that the male gender was significantly associated with acceptance of a COVID-19 vaccine, however, our study did not find this association of the male demographic with vaccine acceptance [38].

Our findings revealed that Confidence, Convenience, and Complacency were statistically significant contributors to vaccine hesitancy, a finding documented in previous literature [39,

40]. A study done in China found a similar impact of Confidence and Complacency indicator on vaccine hesitancy [41]. Bearing this in mind, if policymakers work towards increasing confidence and convenience for the vaccine while decreasing complacency towards vaccine amongst the general population, they can subsequently variate the community's intention to vaccinate significantly, this can be done by adopting tailored interventions for the context at hand concerning the different groups in the country, an approach supported in previous literature [42]. Masks are an easy and effective way to prevent COVID-19 which are reccomended majorly [43, 44]. Less adherence to COVID-19 health behaviors i.e low practice of SOPs was established as a contributor to vaccine hesitancy in our study, this finding is consistent with a previous study done in Australia which determined the same for COVID-19 vaccine hesitancy amongst the Australian population [45], similar was also reported in a study done in the US which cited that those who reported negative COVID-19 vaccination intentions had reduced odds of more frequent adherence to social distancing and wearing masks [46].

This research is not without its limitations and warrants enhancements. The data is cross-sectional making it difficult to disentangle causality of whether vaccine hesitancy is due to a lack of knowledge of vaccine and health information or due to the propensity to believe in conspiracy theories. The sample size is adequate, but it may not be truly representative of the entire Pakistani population, respondents were approached via convenience sampling through social networks of the data collectors, and considering that the authors belonged to only two provinces of the country, they were unable to collect equal responses from all the provinces. Furthermore, only 35% of the 224 million population of the country is urban and the country's literacy rate is 60% with a mean of 5.2 years of schooling. While cellphone access is more than 50%, among youth, access to the internet is still however low (15%) [47]. So the generalization of the results for the entire country should be done with caution. At the time of the study, the USD to PKR currency exchange rate was taken at 1 USD = 158.27 PKR from December 1st, 2020 open market rate at lower end closing. The currency conversion rate is bound to change with the economic instability of the country, so it is advised to future researchers to explore the willingness-to-pay (WTP) for future vaccinations, bearing in mind the most recent currency exchange rate for the time point that they carry out their research. Furthermore, it is also advised to future researchers to explore the WTP and capacity to pay for each province by reaching individuals who do not have access to technology/internet to have a true picture of the provincial statistics so the results could be generalized for the whole province, thereby having a more representative statistic for the country. Vaccine hesitancy is a multifaceted problem, for which a better evaluation could be done via having a larger sample size with a longitudinal sampling approach and open-ended questions.

Conclusion

Our study revealed that there was a significant knowledge gap regarding the vaccine. The belief in myths, like vaccine causes death, allergic reactions, and is more dangerous than the virus itself, was rampant. A lack of confidence in the vaccine, lack of convenience for the vaccine, and increased complacency were significant contributors to vaccine hesitancy. In light of the scale and scope of this major issue, all government and non-governmental health care departments must work together to restore trust in vaccines. The risk of vaccine-preventable disease (VPD), benefits of a vaccine for that VPD, and the risk-benefit ratio of the vaccine need to be discussed, supported by evidence-based medicine, with the hesitant people in a longitudinal, comprehensive, coherent, and in an unbiased transparent fashion to increase vaccination uptake [37]. It is important to educate the public through mass outreach initiatives, awareness campaigns, and conferences to alleviate fear and uncertainty about the safety and efficacy of all

vaccines and bridge the knowledge gap [39]. Efforts to increase vaccine convenience and decrease complacency towards the COVID-19 vaccine would result in high vaccine uptake and a consequential faster herd immunity thereby decreasing the spread of infection and help in curbing the pandemic.

Supporting information

S1 Table. Independent Sample t-test for knowledge, confidence, convenience, complacency and SOP Practice between Healthcare Workers (HCW) and non-healthcare workers.
(DOCX)

S1 Appendix.
(PDF)

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