

## Article

# COVID-19 Vaccination Acceptance in the Context of the Health Belief Model: Comparative Cross-Sectional Study in Punjab, Pakistan

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**Abstract:** One of the models that could be used to understand the adoption of vaccine uptake is the Health Belief Model (HBM). The aim of this study is to assess the role of HBM constructs and perceived health status (PHS) on vaccination status of individuals and to understand the role of socio-demographic variables on HBM scoring. A comparative cross-sectional telephone survey was conducted among 1,325 vaccinated (60.0%) and non-vaccinated (40.0%) vaccinated individuals aged 40 years and above in July 2021 in Punjab province, Pakistan. A higher level of education was the strongest predictor of positive HBM. All constructs of HBM, PHS and cues-to-action were significant predictors of COVID-19 vaccination uptake with perceived benefits as the strongest predictor. In order to expand the vaccination coverage, doubled pronged interventions utilizing both ICT and human resources should be designed that address each barrier perceived by individuals and understandably communicate the benefits of COVID-19 vaccine to the broader population.

**Keywords:** Corona; SARS-CoV-2; vaccine; mass media; cues-to-action; health status

## 1. Introduction

Following the rapid global spread of COVID-19, a public health emergency was declared worldwide in March 2020. Authorities at local, national and international levels introduced a range of precautionary and safety measures to reduce the spread of the virus. The rapid emergence of the COVID-19 pandemic created a situation that health authorities went from recognizing a new pathogen (SARS-CoV-2) to develop and implement an effective vaccine against COVID-19 in less than a year. Before, mumps vaccine was reported to be developed and deployed in the shortest span, which took almost four years in the 1960s [1].

The United Kingdom was the first country to introduce, test and inoculate its population with the mRNA-based COVID-19 vaccine in December 2020 [2]. All countries followed starting their vaccination drive with different vaccines available in varying intervals. However, one of the biggest challenges that public health experts faced after the initiation of vaccination drive was COVID-19 vaccine hesitancy [3,4,5]. This has not only been observed in vulnerable populations [6], but also among health professionals and medical students [7]. Literature highlights various psychological [5,8], social [5,9], economic and personal factors associated with vaccine hesitancy worldwide [9].

Vaccine availability alone does not guarantee the effectiveness of vaccination drive [10]. Therefore, addressing vaccine hesitancy and fostering the confidence of masses in vaccine uptake is essential [8]. Widespread health education by awareness campaigns and strategies are needed to ensure the effectiveness and efficacy of the vaccination drive [3]. Researchers and public health experts focused on different epidemiological, behavioral and social models to understand the behavior regarding the uptake of COVID-19 vaccine. One of the models that could be used to understand the adoption of healthy behavior is the Health Belief Model (HBM) [11].

HBM states that the perceived severity and susceptibility of a disease or a health risk as well as perceived benefits and barriers of a treatment or vaccine play a vital role in predicting the adoption of healthy and preventive behavior among individuals [12,13]. In the past, HBM has been conceptualized to understand the acceptance of masses towards swine flu and seasonal influenza vaccine [14-18] as well as towards out of pocket payment for hepatitis B vaccine [15]. Similarly, this model is now being used to understand people's perceptions and acceptance towards COVID-19 vaccine, because all theoretical constructs of HBM have a significant impact on the intentions of getting vaccinated [11,19]. In a survey experiment conducted by Zampetakis and Melas (2021) in Greece, 57% of the variance in the intention of getting COVID-19 vaccine was explained by the theoretical constructs of HBM [19]. In addition to the role of the theoretical construct of HBM, self-reported health (SRH) also plays a significant role in predicting the health outcomes and adoption of preventive behavior among individuals [20]. SRH is an individual's perceived social, mental and physical well-being [20] which is directly associated with various health outcomes and predicts the use of health services [20,21].

This paper is part of broader post-vaccination survey of COVID-19. In the present study, SRH has been used to assess the Perceived Health Status (PHS). This study has been set up to introduce PHS as an additional construct of HBM in explaining COVID-19 vaccination acceptance. The specific aim is to assess the role of HBM constructs including PHS on vaccination status of individuals and to understand the role of socio-demographic factors on HBM constructs. Lastly, this paper also evaluates the role of mass media as cues-to-action on health decision in terms of vaccine uptake.

## 2. Materials and Methods

### 2.1. Study design

A comparative cross-sectional study was conducted among 1,325 vaccinated (60.0%) and non-vaccinated (40.0%) individuals aged 40 years and above from 8th July to 26th July 2021 in Punjab province, Pakistan. More than half of Pakistan's population is residing in its largest province Punjab. The age group of 40 years and above was chosen because vaccine roll-out, starting from senior citizens, was followed in a decreasing age order. We assumed the majority of individuals to be vaccinated and only reluctant and/or hesitant individuals to be non-vaccinated in this age group. Contact details of the target population was provided by Primary and Secondary Healthcare Departments in Punjab. Official landlines were used for data collection via a telephone-based survey. We estimated the sample size by using Cochran's formula with the assumptions of 95% confidence interval, 3% margin of error, and adjustment for non-response. According to this, the total required sample was calculated to be 1,284. Out of a random sample of 3,550 individuals which were reached via telephone, 1,350 completed the questionnaire. We excluded 25 questionnaires because responses to more than 20% of questions were missing. This led to an overall response rate of 38%.

Telephone interviews were chosen for data collection due to the mobility restriction imposed by pandemic. We used a standardized questionnaire with close-ended questions. The questionnaire used was developed after extensive literature review and under the guidance of public health experts and bio-statisticians. A pre-test on 10% of the minimum required sample (128 respondents) was conducted. These data were not included in the

final sample. Data was collected by a team of 15 persons who also assessed in the pre-test whether there were any redundant, repetitive, unclear or difficult to comprehend questions. After revising the questionnaire according to the comments and feedback provided in the pre-test, the final version of the questionnaire was developed.

## 2.2. Measures

Overall, the questionnaire had six sections. However, only four of the concerned sections are relevant for this analysis. The first section measured the socio-demographic profile that includes age, sex (male, female), religion (Islam, Christianity, other), educational level, monthly household income ( $\leq$ PKR 20,000, PKR 20,001-50,000, PKR 50,001-100,000, above PKR 100,000), employment status, area of residence (rural, urban, semi-urban), city of residence, marital status, and number of children (if married). The second section focused on measuring media sources (television, mobile phone, newspaper, internet, and social media) used and most relied on for getting COVID-19-related information. This question has been used to assess cues-to-action. The third section measured the vaccination status and health status of the individuals. Respondents were asked whether they are vaccinated or not. This was followed by a question of Self-reported Health Status (SRH)/Perceived Health Status (PHS) allowing the respondents to rate their current health status using a 5-point Likert scale ranging from “very poor” to “very good” [22] that was further recoded into three categories (poor, fair, good) for bivariate analyses.

The last section focused on measuring the perception of individuals regarding COVID-19 infection and vaccination according to the theoretical constructs of HBM. Perceived Susceptibility (P-SUS) is measured through one question (“Do you believe that there are confirmed or suspected cases of COVID-19 in the country?”) with three categories (yes, no, not sure). Perceived Severity (P-SEV) was measured by the question “Do you believe that there is a threat of COVID-19 infection?” with a three-point scale (low, fair, high). For further analyses, the option “low” was recoded as “no” while the options “fair” and “high” were combined as “yes”. Perceived Benefits (P-BEN) were measured by two questions: “Do you perceive any benefits of getting vaccination?” and “Do you think that COVID-19 vaccination is an effective way of controlling and preventing the virus?”. Perceived Barriers (P-BAR) were also calculated by two questions: “Do you perceive any barriers in getting vaccination?”, followed by a list of checklist including various barriers (distance to COVID-19 vaccine centers, cost of visit to obtain the vaccine, waiting time at the center, fear of getting infection at the center, lack of trust on the vaccine, lack of trust on the healthcare worker, perceived side effects of vaccine, false/misinformation about the vaccine and any other). Response of “yes” to any barrier was considered “Yes”, while responses of “No” for all barriers was considered “No” in the final variable.

## 2.3. Statistical analysis

For analyzing the role of socio-demographic factors on HBM, all theoretical constructs of HBM were computed. The role of having a high P-SUS, P-SEV and P-BEN is assumed to have a positive impact on adopting a preventive behavior whereas the role of having a high P-BAR is considered to negatively impact on healthy behaviors. For that reason, the direction of P-BAR was changed by transforming the variable and then all four theoretical constructs were computed. The value of the final variable ranged from 0–4, where 0–2 is considered as low scoring on HBM that translates into “Poor COVID-19 knowledge”, while the range of 3–4 is considered as a high score on HBM translating into “Good COVID-19 knowledge”.

For statistical analysis, SPSS version 26 was used. Descriptive analysis is presented in percentages, frequencies or means including standard deviation. For further analysis, Odds Ratios (OR) and Adjusted Odds Ratios (AOR) were calculated by binomial regression and hierarchical multiple binary regression. Hierarchical regression analysis was applied in

eight steps to assess the predictive power of each variable in the overall model in COVID-19 vaccine uptake.

2.4. Ethical considerations

The study protocol has been approved by the Institutional Ethics Review Board, University of the Punjab (D/No: 182/DFEMS/PU). All respondents were assured about the privacy, confidentiality and anonymity of the data and were conveyed about their voluntary participation. Informed consent was taken from all participants.

3. Results

3.1. Characteristics of study participants

A total of 1,325 respondents were included in analysis. 60% of the total respondents were completely vaccinated while the rest was not vaccinated. The majority of respondents were male (73.4%) and in the age group 40–49 years (48.8%), with a mean age of 51.2 years (SD±9.34). In addition to this, most of the respondents resided in urban areas (77.7%), follow Islam as a religion (96.1%), had a monthly income between PKR 20,001–50,000 (44.7%), were currently married (94.1%), had 3–4 children (48.0%), middle level of education (36.0%), high access to media (42.7%), and were employed (65.1%) (Table 1).

Table 1. Characteristics of study participants

Characteristics	n <sup>1</sup>	%
<b>Vaccination status</b>		
Vaccinated	795	60.0
Not Vaccinated	530	40.0
<b>Sex</b>		
Male	972	73.4
Female	353	26.6
<b>Age (in years)</b>		
40–49	646	48.8
50–59	421	31.8
60–69	192	14.5
70–79	52	3.9
80+	14	1.1
<b>Mean age (in years) ± SD</b>	51.2	± 9.34
<b>Area of residence</b>		
Rural	266	20.2
Urban	1024	77.7
Semi-urban	28	2.1
<b>Religion</b>		
Islam	1270	96.1
Christianity	51	3.9
Others	1	0.1
<b>Monthly household income</b>		
≤PKR 20,000	355	30.3
PKR 20,001–50,000	525	44.7
PKR 50,001–100,000	201	17.1
>PKR 100,000	92	7.8
<b>Marital status</b>		
Currently married	1234	94.1
Not currently married <sup>2</sup>	78	5.9
<b>Number of children</b>		
0	40	3.2

1–2	289	23.0
3–4	603	48.0
5 and above	325	25.9
<b>Highest level of education</b>		
No formal education	223	16.9
Primary (1–5 years)	109	8.3
Middle (6–10 years)	474	36.0
Secondary (11–12 years)	168	12.8
Higher (13 years and above)	343	26.0
<b>Employment status</b>		
Employed	853	65.1
Not employed <sup>3</sup>	458	34.9
<b>Access to mass media</b>		
No access	42	3.2
Low access <sup>4</sup>	235	17.8
Moderate access <sup>5</sup>	478	36.3
High access <sup>6</sup>	562	42.7

<sup>1</sup> Values do not sum up to 1325 in all variables due to missing responses (Refused, Not applicable, I don't know)

<sup>2</sup> Includes widow/widower, divorced, separated and single

<sup>3</sup> Includes housewife and retired

<sup>4</sup> Access to one information source,

<sup>5</sup> Access to 2–3 information sources

<sup>6</sup> Access to 4 or more information sources

Overall, slightly more than half of the respondents (56.6%) had good COVID-19-related knowledge. The AOR indicate that being a resident of urban areas (AOR=1.40, 95% CI: 1.02–1.92), having middle (AOR=1.82, 95% CI: 1.24–2.68) and high level of education (AOR=2.36, 95% CI: 1.45–3.83), being currently married (AOR=2.03, 95% CI: 1.02–4.03), and having 1–2 children (AOR=0.03, 95% CI: 1.04–5.08) significantly predict having good COVID-19 knowledge (Table 2).

**Table 2.** Socio-demographic characteristics and HBM

Characteristics	COVID-19-related knowledge				OR (95% CI)	p-value	AOR (95% CI)	p-value
	Poor		Good					
	n	%	n	%				
Sex								
Male	403	42.2	553	57.8	1		1	
Female	165	57.8	187	42.2	0.82 (0.64–1.05)	0.12	0.68 (0.46–1.01)	0.05
Age (in years)								
40–49	277	43.6	359	56.4	1		1	
50–59	172	41.3	244	58.7	1.09 (0.85–1.40)	0.47	1.10 (0.82–1.46)	0.51
60–69	85	44.5	106	55.5	0.96 (0.69–1.33)	0.81	1.07 (0.72–1.59)	0.71
70–79	25	49.0	26	51.0	0.80 (0.45–1.42)	0.45	1.41 (0.67–2.96)	0.35
80+	9	64.3	5	35.7	0.42 (0.14–1.29)	0.13	0.70 (0.19–2.57)	0.59
Area of residence								
Rural	146	55.5	117	44.5	1		1	
Urban	409	40.4	603	59.6	1.84 (1.39–2.41)	<0.01*	1.40 (1.02–1.92)	0.03*
Semi-urban	11	39.3	17	60.7	1.92 (0.87–4.27)	0.10	1.88 (0.74–4.74)	0.17
Monthly household income								
≤PKR 20,000	186	53.0	165	47.0	1		1	





Yes	896	67.8	649	81.9	247	46.7	5.18 (4.04–6.65)	<0.01*
No	425	32.2	143	18.1	282	53.3	1	
<b>P-BAR</b>								
Yes	678	51.4	300	38.0	378	71.3	1	
No	641	48.6	489	62.0	152	28.7	4.05 (3.20–5.14)	<0.01*
<b>PHS</b>								
Poor	81	6.1	30	3.8	51	9.6	1	
Fair	361	27.3	217	27.3	144	27.2	2.56 (1.56–4.21)	<0.01*
Good	882	66.6	547	68.9	335	63.2	2.78 (1.73–4.45)	<0.01*
<b>Access to mass media (cue-to-action)</b>								
No access	42	3.2	21	2.7	21	4.0	1	
Low access	235	17.8	106	13.5	129	24.4	0.82 (0.43–1.59)	0.56
Moderate access	478	36.3	281	35.7	197	37.2	1.43 (0.76–2.68)	0.27
High access	562	42.7	380	48.2	182	34.4	2.09 (1.11–3.92)	0.02*

\*significant p-value

Table 4 describes the results of the multivariate hierarchical regression analysis, which was performed on eleven variables (P-SUS, P-SEV, P-BEN, P-BAR, PHS, age, sex, region, monthly family income, access to mass media, and educational level) in eight steps. In the first four steps, all four constructs of HBM were added one by one to analyze the predictive value of each variable. P-SUS, P-SEV and P-BAR significantly predict the vaccination status of individuals (model 3). However, the addition of P-BEN in model 4 reduces the role of P-SEV and makes its role insignificant (AOR=1.29, 95% CI: 0.97–1.70).

Similarly, PHS significantly predicts the vaccination status ( $p<0.01$ ) in model 5, while P-SEV remains insignificant. In the next step, age, sex, region and income were added collectively considering them as socio-demographic variables.

It can be seen in model 6 that having high P-SUS (AOR=1.68, 95% CI: 1.23–2.30) and P-BEN (AOR=3.35, 95% CI: 2.53–4.43), low P-BAR (AOR=3.35, 95% CI: 2.53–4.43), average (AOR=2.88, 95% CI: 1.48–5.59) or good PHS (AOR=2.41, 95% CI: 1.27–4.54), being in the age group of 60–69 years (AOR=1.73, 95% CI: 1.13–2.65), being female (AOR=0.53, 95% CI: 0.38–0.72), and residing in urban areas (AOR=2.34, 95% CI: 1.66–3.30) are factors associated with a higher likelihood to get vaccinated against COVID-19, while the predictive role of monthly family income remains insignificant.

In the seventh step, access to mass media was added. However, it does not make any significant difference except for making the predictive role of having a monthly family income of above PKR 100,000 (AOR=0.50, 95% CI: 0.28–0.89) significant.

In the last step, educational level has been added considering it as the strongest predictor of positive HBM (which is good COVID-19-related knowledge). It can be seen in model 8 that having middle (AOR=3.92, 95% CI: 2.50–6.16), secondary (AOR=4.38, 95% CI: 2.44–7.84), and higher level of education (AOR=4.53, 95% CI: 2.60–7.90) compared to no formal education significantly predicts COVID-19 vaccine uptake, while reducing the predictive value (AOR) of each significant predictor very slightly, except for the AOR of having average or good PHS which increased.

Overall, the data suggests that P-SUS, P-BEN, P-BAR, and average or good PHS significantly predict the COVID-19 vaccine uptake in respondents beyond the presence of socioeconomic variables, while the role of P-SEV and access to mass media remains insignificant with education level as the strongest predictor followed by P-BEN, P-BAR and PHS, respectively.

Table 4. Multivariate hierarchal regression analysis for factors affecting vaccination uptake

		Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
		AOR	AOR	AOR	AOR	AOR	AOR	AOR	AOR
		(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)	(95% CI)
P-SUS	No	(1)							
	Yes	2.07*	1.97*	2.20*	1.47*	1.49*	1.68*	1.63*	1.54*
		(1.64–2.62)	(1.56–2.50)	(1.70–2.83)	(1.11–1.94)	(1.13–1.98)	(1.23–2.30)	(1.19–2.23)	(1.11–2.13)
P-SEV	No	(1)							
	Yes		1.43*	1.50*	1.29	1.27	1.23	1.26	1.27
			(1.12–1.83)	(1.15–1.95)	(0.97–1.70)	(0.96–1.68)	(0.90–1.66)	(0.93–1.72)	(0.92–1.74)
P-BAR	Yes	(1)							
	No			4.31*	3.66*	3.698*	3.35*	3.43*	3.53*
				(3.37–5.51)	(2.83–4.75)	(2.85–4.78)	(2.53–4.43)	(2.58–4.56)	(2.63–4.74)
P-BEN	No	(1)							
	Yes				3.99*	3.90*	3.93*	3.82*	3.67*
					(3.02–5.26)	(2.95–5.16)	(2.88–5.34)	(2.80–5.21)	(2.66–5.06)
PHS	Poor	(1)							
	Average					2.82*	2.88*	2.95*	3.05*
						(1.57–5.05)	(1.48–5.59)	(1.50–5.81)	(1.51–6.13)
	Good					2.80*	2.41*	2.53*	2.66*
						(1.61–4.87)	(1.27–4.54)	(1.32–4.84)	(1.36–5.19)
Age (in years)	40–49	(1)							
	50–59						1.12	1.20	1.37
							(0.82–1.53)	(0.88–1.65)	(0.99–1.90)
	60–69						1.73*	1.84*	2.13*
							(1.13–2.65)	(1.19–2.84)	(1.36–3.35)
	70–79						0.96	1.01	1.06
							(0.44–2.08)	(0.46–2.23)	(0.45–2.48)
	80+						0.79	0.91	1.38
							(0.23–2.75)	(0.25–3.26)	(0.37–5.05)
Sex	Male	(1)							



Region	Female	(1)	0.53*	0.53*	0.61*
			(0.38–0.72)	(0.38–0.73)	(0.43–0.85)
	Rural		2.34*	2.17*	1.74*
	Urban		(1.66–3.30)	(1.53–3.08)	(1.20–2.51)
Income (in PKR)	Semi-urban	(1)	0.61	0.60	0.45
			(0.21–1.75)	(0.21–1.73)	(0.15–1.34)
	≤20,000		1.12	1.02	0.86
	20,001–50,000		(0.80–1.55)	(0.73–1.43)	(0.60–1.23)
Access to mass media	50,001–100,000	(1)	0.99	0.81	0.56*
	100,000–>100,000		(0.65–1.52)	(0.52–1.26)	(0.35–0.91)
	No access		0.65	0.50*	0.34*
	Low access		(0.38–1.12)	(0.28–0.89)	(0.18–0.62)
Educational level	Moderate access	(1)		0.57	0.45
	High access			(0.25–1.28)	(0.19–1.01)
	No formal education			1.13	0.69
	Primary			(0.52–2.45)	(0.31–1.53)
	Middle	(1)		1.40	0.71
				(0.64–3.07)	(0.31–1.60)
					1.22
					(0.67–2.23)
		(1)			3.92*
					(2.50–6.16)

Secondary	4.38*
	(2.44–7.84)
Higher	4.53*
	(2.60–7.90)

\*significant p-value

#### 4. Discussion

Various cross-sectional studies have evaluated the role of theoretical constructs of HBM in order to predict the adoption of healthy or preventive behaviors such as for influenza [14-18, 23, 24], swine flu [14, 15] and hepatitis B [15] vaccine uptake. Considering the vaccination hesitancy related to COVID-19, epidemiologists and psychologists showed great interest in evaluating the role of theoretical constructs of HBM in the vaccination uptake [11] as well as in the adherence to precautionary measures [25] and preventive behavior of COVID-19 [26].

Results of this study reveal that despite of the efforts which have been taken at local, national and international level for informing people about the risk of COVID-19 and vaccination benefits, a reasonable proportion of the adult population in our sample underestimated the risk of disease and perceived barriers in getting themselves vaccinated. However, this study provides a further piece of evidence that all theoretical constructs of HBM as well as PHS have direct and significant effects on the predicting intention of getting COVID-19 vaccine, with P-BEN having the largest impact on COVID-19 vaccination acceptance followed by P-BAR, fair or good PHS, P-SEV and P-SUS, respectively. However, when adjusted for socio-demographic variables, the role of P-SEV becomes insignificant. Moreover, this study finds cues-to-action, such as access to mass media, to be positively associated with the vaccination status of individuals.

Our results echo the findings of previous studies. For example, in a survey experiment study conducted in Greece [19], all theoretical constructs of HBM were found to be significantly associated with COVID-19 vaccination uptake with P-BEN being the strongest predictor followed by P-BAR, P-SEV and P-SUS respectively. Similarly, in a cross-sectional study conducted in Malaysia, Wong and colleagues [11] found higher levels of P-SEV, P-SUS and P-BEN to be positively associated with the intentions of getting vaccinated against COVID-19, while low levels of P-BAR were positively associated with COVID-19 vaccine uptake intentions. Shmueli (2021) also found P-SEV, P-BEN and cues-to-action as significant predictors of COVID-19 vaccine uptake intention [27]. However, no significant association of PHS with vaccine intention was found in both of these studies [11, 27].

A study conducted in Hong Kong reported P-SEV, P-BEN, P-BAR, SRH (PHS) and cues-to-action to be significantly correlated with COVID-19 vaccine acceptance [28], yet Mercadante and Law (2021) [29] found P-BEN and cues-to-action to positively predict the intention to get vaccinated. However, in another study conducted on the intentions for the uptake of H1N1 influenza vaccine, no evidence was found for a significant relation for P-SUS and P-SEV, whereas P-BEN and P-BAR were significant predictors of vaccine uptake [23]. Likewise, in a study conducted in Pakistan, Shah and colleagues (2021) [30] evaluated the role of HBM constructs in the adherence of preventive measure of COVID-19 and found the significant role of P-BEN, while the role of all other constructs in the adoption of preventive behavior, including cues-to-action, remained insignificant.

Previous studies correlate socio-demographic variables with the intention and likelihood of getting vaccinated against COVID-19 and found that males are more likely than females to accept COVID-19 vaccination [11, 27, 31]. Literature also indicates that the higher immunization hesitancy among females is due to the belief that COVID-19 vaccines may cause infertility [32]. Our study results confirm the lower likelihood for vaccine uptake among women, even when adjusted with theoretical constructs of HBM and PHS. In addition to this, previous research has shown that age [27, 29, 31, 33-40], income [11, 29, 36, 39, 41, 42, 45], education [11, 27, 34, 36-38, 41], working status [31, 38, 45, 46], marital status [42-44], access to mass media, and area of residence [34, 37, 43, 47-49] are significant predictors of COVID-19 vaccine acceptance. Our study provides insights that when HBM constructs and PHS are adjusted for socio-demographic variables, the role of gender, age, area of residence, income and education remain significant. Level of education was even the strongest predictor of COVID-19 vaccine uptake, while the role of access to mass media (cues-to-action) became insignificant. In addition to this, this study evaluates the role

of socio-demographic variables in scoring well on HBM. It was found that individuals who have a middle, secondary, or higher level of education, reside in urban areas, have a monthly income of more than PKR 20,000, have high access to media, and are currently married are more likely to score well on HBM and have good COVID-19-related knowledge, while sex, age, number of children, and working status are not significant predictors of scoring well on HBM.

In summary, the findings of the present study shed light on the direct implications of theoretical constructs of HBM, PHS as well as on those people who are less likely to score positive on HBM model. These results help to understand COVID-19 vaccine hesitancy among the broader population. The present study finds that all four theoretical constructs of HBM, PHS and cues-to-action significantly predict the COVID-19 vaccination intention. Findings reveal that higher educational level is the strongest predictor of COVID-19 vaccine uptake. These findings highlight the importance and need of education. Even though access to mass media was not a significant predictor, the overall results also shed light on the impact of media health literacy campaigns regarding COVID-19 infection and vaccination. This can be informed about in public service messages on television and social media and COVID-19 related messages as caller tunes, as far as the population is able to differentiate between evidence-based materials and fake or misleading information.

However, the fact cannot be neglected that when educational campaigns are integrated with information and communication techniques (ICT), it subjects the vulnerable and marginalized communities into a more vulnerable state [50-52], especially in the socio-demographic context of Pakistan, where more than half of the population resides in rural areas [53]. Therefore, there is a need to design double pronged health education and information campaigns that integrate ICT as well as human resources. The present study recommends that in order to expand the vaccination coverage, interventions should be designed in a way that target the. Tailored strategies like door-to-door vaccination campaigns with health education messages integrating ICT as well as health professionals and healthcare workers could be utilized to specifically target the marginalized communities and refusal cases. Lastly, considering the significant estimates of PHS in predicting the COVID-19 vaccine uptake, it is recommended for future studies to further evaluate its impact as an additional construct of HBM with varying disease models.

The results of our study have to be interpreted with caution, because it is a cross-sectional study which does not necessarily allow to draw causal conclusions. Our results are based on comparing vaccinated against non-vaccinated persons. However, due to the dynamic situation of the COVID-19 pandemic, these results may only be a spotlight, which is time-dependent and also depending on the political and social environment. In addition, the results may be valid for the province of Pakistan, and are not necessarily transferable to countries with different cultural backgrounds.

## 5. Conclusions

This study shows the significant role of all the theoretical constructs of HBM and PHS in predicting preventive behavior of vaccination during the COVID-19 pandemic. P-BAR and P-BEN have been the strongest predictors for healthy behavior and having a high level of education as the strongest predictor of positive scoring at HBM. Given the significant role of PHS, there is a need to further investigate its role in predicting the adoption of healthy or preventive behaviors among people of different socio-demographic profiles. Lastly, for achieving vaccination coverage, given the high P-BAR as the strongest negative predictor for vaccination status of respondents, there is a need to identify, address and eliminate each barrier perceived by respondents. Given the impact of P-BEN as positive predictor for vaccine uptake, the right kind of information needs to be disseminated in order to convey individual as well as collective benefits that could be achieved by universal vaccination coverage.

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