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Original Article

Determinants of COVID-19 pediatric vaccine hesitancy and uptake among parents from Pakistan

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Parental hesitancy to vaccinate their children may be an obstacle to achieving herd immunity against COVID-19. The current study was aimed to assess the prevalence of parental vaccine hesitancy, vaccine uptake, and factors associated with these behaviors. A web-based descriptive study design was used in this study. A self-administered questionnaire was used to collect data conveniently from Pakistani parents with children younger than 18 years. The participants self-reported the vaccination status among their children along with their socio-demographic details and attitudes towards COVID-19 vaccination in children. The association between different variables was assessed using the Chi-square test, while logistic regression analysis was performed to assess the predictors of vaccine hesitancy and uptake. Among the 386 study participants, 30 % were hesitant to be vaccinated, while 70 % got their children vaccinated against COVID-19. The younger parents, having one child (<12 years), were more hesitant to vaccinate them. Vaccine uptake was most commonly reported among participants who agreed with the safety and effectiveness of the COVID-19 vaccine in children. Health authorities should start educational campaigns to convince hesitant Pakistani parents about the benefits and safety of pediatric vaccination in order to promote the vaccination of children against COVID-19.

Keywords: COVID-19; children; immunization; parents; vaccine hesitancy.

Introduction

One of the supreme achievements of modern-day medicines is the development of vaccines to save lives by preventing the outbreak of infectious diseases.(1) Vaccination programs are considered the most effective public health strategy against infectious diseases, and are predicted to prevent 5.2 million deaths annually.(2) The eradication of smallpox and the near eradication of polio are evidence of the mass vaccination programs' success.(3) Various epidemiological and clinical studies have demonstrated the beneficial effects of vaccination, like reduction of incidence by prevention, and decrease in the severity of infectious diseases. In addition to these benefits, vaccination also lessens the social and economic impact of diseases.(4)

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The development of the COVID-19 vaccine played an essential role in controlling the pandemic situation.[5] COVID-19 vaccines are safe and effective with a high efficacy (70 % to 95 %) and tolerable adverse effects. Among them, mRNA based vaccines have had the highest effectiveness (94.29 %) and mostly have some severe adverse effects like headache, fatigue, and pain.[6] At the beginning, COVID-19 vaccines were approved only for adults. Later, vaccination of children and adolescents was also recommended, after getting further safety data.[7] It is necessary to vaccinate children and adolescents against COVID-19 to protect them from the adverse impact of the disease and to attain herd immunity.[8] In Pakistan, pediatric COVID-19 vaccination was approved in September 2022 for children above 5 years of age and subsequently parents were advised to vaccinate their children.[9]

Vaccine hesitancy is defined as "a delay in acceptance or refusal of vaccination despite the availability of vaccination services. Vaccine hesitancy is complex and context-specific, varying across time, place, and vaccines. It is influenced by factors such as complacency, convenience, and confidence."[10] It is considered one of the top 10 threats to public health and acts as a significant hurdle in the success of vaccination campaigns.[11,12] The vaccine uptake is defined as the use of a vaccine in an immunization program.[13] Like other vaccination programs, the COVID-19 vaccination campaign also faced vaccine hesitancy as a major hurdle to its success which is relatively more prevalent in a country like Pakistan where conspiracy theories are commonly believed by the general population as propaganda of Western countries to suppress the Muslim nations.[14,15,16] The worldwide parental COVID-19 vaccination acceptance rate for their children was lower than the general public's COVID-19 vaccine acceptance rate.[17,18]

To the best of our knowledge, parental vaccination hesitation in immunizing their children against COVID-19 had not been thoroughly investigated in Pakistan until the conduction of the current study, regardless of a previous study from four districts of Pakistan.[9] To investigate this issue of great importance in detail, the current study set out to evaluate parental uptake of COVID-19 vaccine and hesitancy to vaccinate their children, to evaluate parental attitudes towards children's COVID-19 vaccination and to identify the factors associated with vaccine uptake and hesitancy.

Materials and Methods

Study design

This study was conducted in Pakistan using a descriptive web-based cross-sectional study design. Every parent citizen of Pakistan with children aged 5-18 years was eligible to participate in this study. The vaccination was approved for children above 5 years throughout the country in September 2022.[9] The analysis did not include the responders who declined to participate after reading the study's introduction letter (informed consent). The eligibility requirements to participate in the study were: to be a Pakistani citizen and to have at least one child aged 5-18 years.

Sample size

A minimum sample was calculated using Raosoft, an online sample size estimator to represent the target population. A minimal sample size of 377 was computed, with a 5 % margin of error, a 95 % confidence interval, and a 50 % response distribution. As we were not sure about total population of Pakistani parents, so utilized default setting of sample size calculator for unknow population.

Study instrument

The first draft of the current study's self-administered questionnaire (SAQ) was developed using a pre-validated SAQ from a multi-country study in the Eastern Mediterranean area.[19] There were two sections in the SAQ. The first section of the SAQ comprised 19 mandatory questions to gauge individuals' attitudes regarding COVID-19 immunization for children. Participants responded to these questions using a Likert scale (Agree, Neutral, and Disagree).[20] In the second section, participants asked questions about sociodemographic and COVID-19-related information, including their age, gender, marital status, monthly income, professional affiliation, level of education, residential area, history of infections, vaccination status, number of children, and ages of their children.

Validation of SAQ

The SAQ was initially created in English and then translated into Urdu by local multilingual specialists. Before to final approval, a panel of topic specialists in Pharmacy Practice and Public Health reviewed the SAQ's content and face validity. A pilot study with 50 respondents was done to ensure the validity of the questionnaire in the intended population. The SAQ was also enhanced in response to comments and questions from pilot research participants. The internal consistency of the SAQ was assured by using commonly used statistical test Cronbach alpha, who's value of 0.8 indicated the reliability of the SAQ.

Ethical considerations

Before administering the SAQ, informed consent was electronically collected from each participant. The people who agreed to participate in the study were only allowed to submit a response against the SAQ after giving background information about the study. The study did not ask questions that could expose participants' identities to minimize Hawthorne bias. The study was approved by the ethical review committee of Department of Pharmacy Practice, Faculty of Pharmacy, Bahauddin Zakariya University, Multan, Pakistan and Declaration of Helsinki was followed in its conduction.

Data collection

A convenient sampling technique was used to collect data from the target population by uploading the study instrument to Google Form (Google LLC, Menlo Park, CA, USA). Then, its online link was shared via various platforms like WhatsApp, Facebook, Email, etc. After that, from 11 January to 22 March 2023, responses were received through this online link for 10 weeks. The checklist for reporting results of internet E-surveys (CHERRIES) guidelines was followed.[21]

Data analysis

The statistical package for the social sciences (SPSS), version 21.0 (IBM, Armonk, NY, USA), was used for data analysis. Descriptive statistics were used to present the study variables; the categorical variables were presented as frequencies (n) and percentages (%). For inferential analysis, the Chi-square test was performed to examine significant differences between categorical variables. A univariate logistic regression analysis was conducted for each significant linked demographic variable to assess the predictors of COVID-19 vaccination uptake and vaccine hesitancy. An alpha value of ≤ 0.05 was considered statistically significant.

Results

A total of 651 responses were received until the 22nd of March, of which 11 were excluded as they didn't consent to participate in the study and 254 responses that didn't meet eligibility criteria were excluded from the final analysis. After this, the remaining 386 responses were included in the final analysis. Among the 386 study participants, 199 (51.6 %) were male, and 187 (48.4 %) were female, with a mean age of 32.8 (SD ± 7.5) years; 276 (71.5 %) had a profession not related to health and 110 (28.5 %) had a health-related profession. Three hundred and fifty-four (91.7 %) participants had been vaccinated against COVID-19. The majority of the study participants, 164 (42.5 %), had at least two children, while 239 (61.9 %) participants had children aged less than 12 years (Table 1).

The association between the research participants' socio-demographic factors and their children's COVID-19 vaccination status by using the Chi-square test is shown in Table 2. This inferential analysis revealed that the age ($p = 0.003$), monthly income ($p = 0.027$), and COVID-19 vaccination status of the study participants ($p < 0.001$) were significantly associated with their children's COVID-19 vaccination status. The children-related details of the study participants, i.e. the number of children ($p = 0.016$) and children's age ($p < 0.001$) were also found to be significantly associated with the vaccination status of their children.

The association of the study participants' responses to the attitude statements regarding COVID-19 vaccination with vaccination status of their children when using the Chi-square test is presented in Table 3. Various attitude statements were found to be significantly associated with the children's COVID-19 vaccination status: vaccination protects children from COVID-19 infection ($p < 0.001$), COVID-19 vaccines

Table 1. Socio-demographic details of the study participants (N = 386).

Variables		Frequency	Percentage
Gender	Male	199	51.6 %
	Female	187	48.4 %
Participant's age (years)	18 to 29	131	33.9 %
	30 to 39	179	46.4 %
	40 to 49	65	16.8 %
	≥ 50	11	2.8 %
Professional belonging	Health-related	110	28.5 %
	Not related to health	276	71.5 %
Education level	Primary (1-5)	10	2.6 %
	Secondary (6-10)	30	7.8 %
	Intermediate (11-12)	49	12.7 %
	Bachelor (13-16)	176	45.6 %
	Master or above	121	31.3 %
Monthly income (PKR)	< 20,000	48	12.4 %
	20,000 to 40,000	71	18.4 %
	40,001 to 60,000	78	20.2 %
	> 60,000	85	22.0 %
	No income	104	26.9 %
Residential area	Rural	158	40.9 %
	Urban	228	59.1 %
Participant's COVID-19 infection history	Yes	80	20.7 %
	No	266	68.9 %
	Maybe	40	10.4 %
Participant's COVID-19 vaccination status	Yes	354	91.7 %
	No	32	8.3 %
Number of children	1	110	28.5 %
	2	164	42.5 %
	3 or More	112	29. 0%
Children's age	Between 12 to 17 years	81	21.0 %
	5 to 12 Years	239	61.9 %
	Have children in both age groups	66	17.1 %

Table 2. Association between socio-demographics details of participants and COVID-19 vaccination status of their children (N = 386).

Variables		Children's COVID-19 vaccination status		P-value
		Yes N (%)	No N (%)	
Gender	Male	137 (68.8 %)	62 (31.2 %)	0.552
	Female	133 (71.1 %)	54 (28.9 %)	
Participant's age (years)	18 to 29	82 (62.6 %)	49 (37.4 %)	0.003
	30 to 39	121 (67.6 %)	58 (32.4 %)	
	40 to 49	56 (86.2 %)	9 (13.8 %)	
	≥ 50	10 (90.9 %)	1 (9.1%)	
Professional belonging	Health-related	80 (72.7 %)	30 (27.3 %)	0.412
	Not related to health	190 (68.8 %)	86 (31.2 %)	
Education level	Primary (1-5)	5 (50.0 %)	5 (50.0 %)	0.225
	Secondary (6-10)	23 (76.7 %)	7 (23.3 %)	
	Intermediate (11-12)	38 (77.6 %)	11 (22.4 %)	
	Bachelor (13-16)	126 (71.6 %)	50 (28.4 %)	
	Master or above	78 (64.5 %)	43 (35.5 %)	
Monthly income (PKR)	< 20,000	35 (72.9 %)	13 (27.1 %)	0.027*
	20,000 to 40,000	51 (71.8 %)	20 (28.2 %)	
	40,001 to 60,000	57 (73.1 %)	21 (26.9 %)	
	> 60,000	67 (78.8 %)	18 (21.2 %)	
	No income	60 (57.7 %)	44 (42.3 %)	
Residential area	Rural	114 (72.2 %)	44 (27.8 %)	0.381
	Urban	156 (68.4 %)	72 (31.6 %)	
COVID-19 infection history	Yes	60 (75.0 %)	20 (25.0 %)	0.494
	No	182 (68.4 %)	84 (31.6 %)	
	Maybe	28 (70.0 %)	12 (30.0 %)	
COVID-19 vaccination status	Yes	259 (73.2 %)	95 (26.8 %)	<0.001*
	No	11 (34.4 %)	21 (65.6 %)	
Number of children	1	65 (59.1 %)	45 (40.9 %)	0.016*
	2	122 (74.4 %)	42 (25.6 %)	
	3 or more	83 (74.1 %)	29 (25.9 %)	
Children's age (years)	12 to 17 years	70 (86.4 %)	11 (13.6 %)	<0.001*
	< 12 years	138 (57.7 %)	101 (42.3 %)	
	Have children in both age groups	62 (93.9 %)	4 (6.1 %)	

* Statistically significant findings ($p \leq 0.05$).

Table 3. Association between participants' responses to attitude statements regarding COVID-19 vaccination for children and the vaccination status of their children (N = 386).

Variables	Total (N=386)	Children's COVID-19 vaccination status		P-value
		Yes	No	
	N (%)	N (%)	N (%)	
COVID-19 vaccines protect children from COVID-19 infection				
Agree	307 (79.5 %)	230 (74.9 %)	77 (25.1 %)	
Neutral	57 (14.8 %)	32 (56.1 %)	25 (43.9 %)	<0.001*
Disagree	22 (5.7 %)	08 (36.4 %)	14 (63.6 %)	
COVID-19 vaccines are safe for children				
Agree	275 (71.2 %)	211 (76.7 %)	64 (23.3 %)	
Neutral	79 (20.5 %)	48 (60.8 %)	31 (39.2 %)	<0.001*
Disagree	32 (8.3 %)	11 (34.4 %)	21 (65.6 %)	
I encourage children’s vaccination against COVID-19				
Agree	279 (72.3 %)	213 (76.3 %)	66 (23.7 %)	
Neutral	70 (18.1 %)	40 (57.1 %)	30 (42.9 %)	<0.001*
Disagree	37 (9.6 %)	17 (45.9 %)	20 (54.1 %)	
COVID-19 infection can occur even after vaccination				
Agree	212 (54.9 %)	144 (67.9 %)	68 (32.1 %)	
Neutral	109 (28.2 %)	78 (71.6 %)	31 (28.4 %)	0.601
Disagree	65 (16.8 %)	48 (73.8 %)	17 (26.2 %)	
Children who were infected with COVID-19 do not need to get vaccinated				
Agree	92 (23.8 %)	61 (66.3 %)	31 (33.7 %)	
Neutral	81 (21.0 %)	54 (66.7 %)	27 (33.3%)	0.406
Disagree	213 (55.2 %)	155 (72.8 %)	58 (27.2 %)	
Natural immunity is better than the vaccine				
Agree	206 (53.4 %)	132 (64.1 %)	74 (35.9 %)	
Neutral	91 (23.6 %)	67 (73.6 %)	24 (26.4 %)	0.018*
Disagree	89 (23.1 %)	71 (79.8 %)	18 (20.2 %)	
Healthy children do not need a vaccine against COVID-19				
Agree	85 (22.0 %)	62 (72.9 %)	23 (27.1 %)	
Neutral	72 (18.7 %)	46 (63.9 %)	26 (36.1 %)	0.430
Disagree	229 (59.3 %)	162 (70.7 %)	67 (29.3 %)	

Table 3. Association between participants' responses to attitude statements regarding COVID-19 vaccination for children and the vaccination status of their children (N = 386). (Cont.)

Variables	Total (N=386)	Children's COVID-19 vaccination status		P-value
		Yes	No	
	N (%)	N (%)	N (%)	
COVID-19 is exaggerated, it's not a risky disease, so no vaccination is needed				
Agree	62 (16.1 %)	41 (66.1 %)	21 (33.9 %)	
Neutral	67 (17.4 %)	44 (65.7 %)	23 (34.3 %)	0.468
Disagree	257 (66.6 %)	185 (72.0 %)	72 (28.0 %)	
Masks, hygiene, social distancing, and other protective measure are enough				
Agree	150 (38.9 %)	102 (68.0 %)	48 (32.0 %)	
Neutral	102 (26.4 %)	70 (68.6 %)	32 (31.4 %)	0.606
Disagree	134 (34.7 %)	98 (73.1 %)	36 (26.9 %)	
I oppose all vaccines for children (not only COVID-19 vaccine)				
Agree	73 (18.9 %)	51 (69.9 %)	22 (30.1 %)	
Neutral	63 (16.3 %)	41 (65.1 %)	22 (34.9 %)	0.639
Disagree	250 (64.8 %)	178 (71.2 %)	72 (28.8 %)	
Vaccination is only needed for the elderly and those with chronic illnesses				
Agree	76 (19.7 %)	54 (71.1 %)	22 (28.9 %)	
Neutral	73 (18.9 %)	47 (64.4 %)	26 (35.6 %)	0.515
Disagree	237 (61.4 %)	169 (71.3 %)	68 (28.7 %)	
COVID-19 vaccine benefits outweigh the side effects				
Agree	177 (45.9 %)	135 (76.3 %)	42 (23.7 %)	
Neutral	119 (30.8 %)	76 (63.9 %)	43 (36.1 %)	0.043*
Disagree	90 (23.3 %)	59 (65.6 %)	31 (34.4 %)	
Children should not be vaccinated because the long-term effects of vaccination are unknown				
Agree	104 (26.9 %)	75 (72.1 0%)	29 (27.9 %)	
Neutral	110 (28.5 %)	75 (68.2 %)	35 (31.8 %)	0.819
Disagree	172 (44.6 %)	120 (69.8 %)	52 (30.2 %)	
Children must be vaccinated if it was recommended by a physician				
Agree	98 (25.4 %)	72 (73.5 %)	26 (26.5 %)	
Neutral	57 (14.8 %)	32 (56.1 %)	25 (43.9 %)	0.046*
Disagree	231 (59.8 %)	166 (71.9 %)	65 (28.1 %)	

Table 3. Association between participants' responses to attitude statements regarding COVID-19 vaccination for children and the vaccination status of their children (N = 386). (Cont.)

Variables	Total (N=386)	Children's COVID-19 vaccination status		P-value
		Yes	No	
	N (%)	N (%)	N (%)	
The government has the right to force everyone to get the COVID-19 vaccine				
Agree	178 (46.1 %)	134 (75.3 %)	44 (24.7 %)	
Neutral	104 (6.9 %)	76 (73.1 %)	28 (26.9 %)	0.006*
Disagree	104 (26.9 %)	60 (57.7 %)	44 (42.3 %)	
COVID-19 vaccine will end the pandemic				
Agree	170 (44.0 %)	132 (77.6 %)	38 (22.4 %)	
Neutral	117 (30.3 %)	83 (70.9 %)	34 (29.1 %)	0.001*
Disagree	99 (25.6 %)	55 (55.6 %)	44 (44.4 %)	
Children should not be vaccinated because vaccination is painful				
Agree	199 (51.6 %)	148 (74.4 %)	51 (25.6 %)	
Neutral	45 (11.7 %)	25 (55.6 %)	20 (44.4 %)	0.039*
Disagree	142 (36.8 %)	97 (68.3 %)	45 (31.7 %)	
Children should not be vaccinated due to a lack of scientific studies about COVID-19 vaccination on children				
Agree	217 (56.2 %)	154 (71.0 %)	63 (29.0 %)	
Neutral	63 (16.3 %)	39 (61.9 %)	24 (38.1 %)	0.299
Disagree	106 (27.5 %)	77 (72.6 %)	29 (27.4 %)	
Vaccines are not effective due to frequent mutations				
Agree	110 (28.5 %)	70 (63.6 %)	40 (36.4 %)	
Neutral	140 (36.3 %)	97 (69.3 %)	43 (30.7 %)	0.118
Disagree	136 (35.2 %)	103 (75.7 %)	33 (24.3 %)	

* Statistically significant findings ($p \leq 0.05$).

Table 4. Univariate logistic regression analysis to assess the predictors of COVID-19 vaccine uptake and COVID-19 vaccine hesitancy for their children among study participants (N = 386).

Predictors		Vaccine uptake					Vaccine hesitancy				
		B	SE	Wald	OR (CI 95%)	Sig.	B	SE	Wald	OR (CI 95%)	Sig.
Participant's age (years)	18 to 29	-1.788	1.064	2.822	0.167 (0.021–1.347)	0.093	1.788	1.064	2.822	5.976 (0.742–48.113)	0.093
	30 to 39	-1.567	1.061	2.182	0.209 (0.026–1.669)	0.140	1.567	1.061	2.182	4.793 (0.599–38.343)	0.140
	40 to 49	-0.474	1.109	0.183	0.622 (0.071–5.465)	0.669	0.474	1.109	0.183	1.607 (0.183–14.115)	0.669
	≥ 50	Ref.					Ref.				
Monthly income (PKR)	< 20,000	0.680	0.381	3.194	1.974 (0.936–4.163)	0.074	-0.680	0.381	3.194	0.506 (0.240–1.068)	0.074
	20,000 to 40,000	0.626	0.330	3.594	1.870 (0.979–3.572)	0.058	-0.626	0.330	3.594	0.535 (0.280–1.021)	0.058
	40,001 to 60,000	0.624	0.320	3.793	1.867 (0.996–3.498)	0.051	-0.624	0.320	3.793	0.536 (0.286–1.004)	0.051
	> 60,000	1.004	0.331	9.177	2.730 (1.425–5.227)	0.002*	-1.004	0.331	9.177	0.366 (0.191–0.702)	0.002*
	No income	Ref.					Ref.				
Participant's COVID-19 vaccination status	Yes	1.635	.391	17.498	5.131 (2.385–11.039)	<0.001*	-1.635	0.391	17.498	0.195 (0.091–0.419)	<0.001*
	No	Ref.					Ref.				
Number of children	1	-0.638	0.288	4.893	.528 (0.300–0.930)	0.027*	0.638	0.288	4.893	1.892 (1.075–3.330)	0.027*
	2	0.061	0.278	0.048	1.063 (0.616–1.834)	0.827	-0.061	0.278	0.048	0.941 (0.545–1.624)	0.827
	≥ 3	Ref.					Ref.				
Children's age (years)	12 to 17 years	-0.651	0.567	1.317	0.522 (0.172–1.585)	0.251	0.651	0.567	1.317	1.917 (0.631–5.826)	0.251
	< 12 years	-2.189	0.483	20.523	0.112 (0.043–0.289)	<0.001	2.189	0.483	20.523	8.929 (3.463–23.023)	0.001
	Have children in both age groups	Ref.					Ref.				

*Statistically significant findings ($p \leq 0.05$).
B: Regression coefficient. SE: standard error. Wald: Wald test statistic. OR: Odds ratio. Sig.: Significance (p-value). Ref. = reference category.

are safe ($p < 0.001$), encouragement of vaccination against COVID-19 ($p < 0.001$), and vaccination against COVID-19 will end this pandemic ($p = 0.001$).

Univariate logistic regression analysis was performed among significantly associated socio-demographic characteristics of the study participants to assess the possible predictors of COVID-19 vaccine uptake and vaccine hesitancy for their children. The participants vaccinated against COVID-19 were 5.131 (2.385─11.039) more likely to get their children vaccinated than unvaccinated participants. The participants having monthly income of more than 60,000 PKR were 2.730 (1.425─5.227) more like to get their children vaccinated than those with no income. The participants with one child were found to be 1.892 (1.075─3.330) times more hesitant than those with three or more children. The study participants whose children were less than 12 years were found 8.929 (3.463─23.023) more hesitant than the reference group (Table 4).

Discussion

Internationally, there is a dearth of published research on children's uptake of the COVID-19 vaccine, and the studies that have been done focus more on parents' intentions than actual immunization rates. The vaccination programs face various barriers that mostly relate to their attitudes towards vaccines as explored by a study from Pakistan.[22] The present research demonstrated that 70 % of Pakistani parents who participated in the study vaccinated their children against COVID-19, and 30 % of them were hesitant to do it. A previous study conducted in four districts of Pakistan reported opposite results, with 75 % of the study participants reporting that their children were unvaccinated against COVID-19.[9] These contrasting results could be due to differences in the beliefs of the study participants, since 60 % did not consider their children at risk of infection, while approximately 50 % mistrusted the safety of COVID-19 vaccines in children. A study from the Eastern Mediterranean Region presented opposite findings to the current study, where 32 % of participants vaccinated their children against COVID-19, and 68 % were hesitant to vaccinate their children;[19] this contrast could be related to their belief about the safety and efficacy of the COVID-19 vaccine. Half of the participants in the previous study from the Eastern Mediterranean Region believed in the safety and efficacy of the COVID-19 vaccine[19] and about three-quarters of the participants from the current study had similar beliefs. This could also be related to the higher number of Arabic people, compared to Pakistanis who believe in conspiracy theories regarding COVID-19 vaccination.[14]

Various significant associations between socio-demographic data and children's vaccination status were found in the current study. Statistical analysis showed ($p = 0.003$) that parents older than 50 years had a higher acceptance of COVID-19 vaccination for their children (90.9 %) than younger parents aged less than 30 years (62.6 %). These findings are consistent with previous studies, where younger parents were more hesitant to vaccinate their children against COVID-19, indicating that younger parents tend to be more hesitant about vaccinating their children due to concerns about vaccine safety, potential side effects, and perceived lower susceptibility of children to severe COVID-19 outcomes,[19,23,24] in contrast, older parents may be more inclined to prioritize vaccination, influenced by their greater perceived vulnerability to COVID-19 and a higher level of trust in public health recommendations, often developed through life experience. In the present research, parents with children under 12 years and parents having one child, were more hesitant. These findings also correlate with previous studies,[19,23,24] which could be due to parents' concern regarding the safety of COVID-19 vaccination in children under 12 years. Additionally, parents with a single child may exhibit greater caution and apprehension about perceived risks, as they may be more protective of their only child. The current study also revealed similar findings to different published studies, i.e., parents vaccinated against COVID-19 were more likely to vaccinate their children.[19,25,26] Vaccinated parents may have greater trust in the safety and efficacy of vaccines and are more likely to perceive vaccination as a necessary step to protect their children. Furthermore, their own positive vaccination experience might reinforce their confidence in the process, reducing hesitancy for their children. The current study found a

significant association between parental income and children's vaccination status, with parents earning more than 60,000 PKR/month being 2.73 times more likely to vaccinate their children compared to those with no income ($p = 0.027$). Higher-income families may have better access to healthcare services and can afford transportation costs or other potential out-of-pocket expenses related to vaccination. Additionally, financial stability might correlate with higher educational levels and greater health literacy, which are known to positively influence vaccine acceptance. In contrast, low -income parents may prioritize immediate financial needs over preventive healthcare and could be influenced by misinformation or lack of awareness about the benefits and safety of vaccines.[27]

The current study also revealed that parents' attitudes toward the children's vaccination against COVID-19 significantly impacted their children's vaccination status. Among the significantly associated attitude statements, those related to the safety and effectiveness of COVID-19 vaccines were positively associated with vaccine uptake. Parents who mistrusted the safety and efficacy of the COVID-19 vaccine were hesitant to vaccinate their children. Participants who believed in natural immunity respect to vaccines were more hesitant to vaccinate their children; these results are similar to other published studies from different countries.[17,19,27] Overcoming undecided parents' concerns about the safety and efficacy of the COVID-19 vaccine could have a positive impact on vaccine acceptance among their children. Belief in natural immunity over vaccination was a significant factor influencing vaccine hesitancy ($p = 0.018$). The fact that parents who prioritized natural immunity were less likely to vaccinate their children could be attributed to misconceptions about the adequacy of natural defenses against COVID-19. Public health interventions addressing the limitations of natural immunity and highlighting the benefits of vaccination could help counter this misconception.

This research also found that parents who believed children should be vaccinated if recommended by a physician were significantly more likely to vaccinate their children ($p = 0.046$). This highlights the influence of healthcare professionals as reliable sources of information. Therefore, encouraging physicians to actively recommend vaccines could be a critical strategy in improving vaccine uptake. Lastly, agreement with the statement that "the government has the right to force everyone to get the COVID-19 vaccine" was positively associated with children's vaccination status ($p = 0.006$). This indicates that parents who support regulatory measures are more likely to comply with vaccination guidelines. However, parents who disagree could have concerns about personal freedoms, which could lead to resistance to the vaccination.

The current study has some limitations that may impact the study findings. The cross-sectional study design and convenient sampling technique could affect the generalizability of the study findings. Due to the self-administered questionnaire and online data collection method, only literate Pakistani parents who had internet facilities participated in the current study, so the study participants may not be the true representative of Pakistani parents, which could be counted as a study limitation.

Conclusions

The current study revealed that 30 % of the study participants (Pakistani parents) were hesitant to vaccinate their children while the remaining 70 % got vaccinated their children against COVID-19. To explore this topic more comprehensively, a study especially targeting the unexplored population (illiterate and without internet facility) with a larger sample size will be required in the future. Health authorities could address this major public health threat (vaccine hesitancy) by promoting the factors positively associated with vaccine uptake. Especially, providing knowledge about the safety and efficacy of vaccines to neutralize parents' concerns regarding vaccines could promote vaccination uptake.

Conflict of interests

The authors declare that there is no conflict of interest.

Author's contributions

Muhammad Subhan Arshad contributed to conceptualization, methodology, validation, formal analysis, data curation, and writing (original draft preparation).

Imran Imran contributed to software, validation, writing (review and editing), and project administration.

Hamid Saeed contributed to methodology, investigation, writing (review and editing), and project administration.

Imran Ahmad contributed to software, investigation, data curation, and writing (original draft preparation).

Muqarrab Akbar contributed to software, investigation, data curation, and writing (original draft preparation).

Muhammad Omer Chaudhry contributed to methodology, formal analysis, and writing (review and editing).

Muhammad Fawad Rasool contributed to conceptualization, methodology, software, formal analysis, investigation, writing (review and editing), project administration, and supervision.

All authors have read and agreed to the published version of the manuscript.

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Determinantes de la reticencia y aceptación de los padres, en Pakistán, frente a la vacunación pediátrica contra la COVID-19

Resumen

La reticencia de los padres a la hora de vacunar a sus hijos puede ser un obstáculo para lograr la inmunidad contra la COVID-19. El objetivo del presente estudio fue evaluar la prevalencia de la vacilación de los padres frente a la vacunación, la aceptación de la vacuna y los factores asociados a estos comportamientos. En este estudio se utilizó un diseño de estudio descriptivo basado en la web. Se utilizó un cuestionario autoadministrado para recopilar convenientemente datos de padres pakistaníes con hijos menores de 18 años. Los participantes informaron del estado de vacunación de sus hijos, junto con sus datos sociodemográficos y sus actitudes hacia la vacunación infantil contra la COVID-19. La asociación entre las distintas variables se evaluó mediante la prueba de Chi-cuadrado, mientras que el análisis de regresión logística se realizó para evaluar los factores predictivos de la reticencia y la aceptación de la vacuna. De los 386 participantes en el estudio, el 30 % dudó vacunarse, mientras que el 70 % vacunó a sus hijos contra la COVID-19. Los padres más jóvenes, con un solo hijo (<12 años), se mostraron más reticentes a vacunarlos. La aceptación de la vacuna fue más frecuente entre los participantes que estaban de acuerdo con la seguridad y eficacia de la vacuna contra COVID-19 en niños. Las autoridades sanitarias deberían iniciar campañas educativas para convencer a los padres pakistaníes indecisos sobre los beneficios y la seguridad de la vacunación pediátrica con el fin de promover la vacunación de los niños contra la COVID-19.

Palabras clave: COVID-19; niños; inmunización; padres; vacilación a la vacuna.

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