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Parental experience with childhood COVID-19 vaccines and factors associated with parental hesitancy despite being vaccinated: findings of a cross-sectional analysis from Pakistan and implications for the future

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ABSTRACT

Objectives This study examined parental experiences with COVID-19 vaccination and factors contributing to COVID-19 vaccine hesitancy (CVH) among them to help guide future policy initiatives.

Design Cross-sectional study.

Setting Lahore, the second largest metropolis in Pakistan.

Participants This study was conducted among parents residing in Lahore from March to April 2023. Participants were recruited via convenience sampling.

Outcome measures Data were collected using a prevalidated questionnaire that consisted of four sections: (1) informed consent, (2) demographic details, (3) COVID-19 vaccine uptake in children aged 5–17 years, parents' experience with childhood COVID-19 vaccination and their intention to vaccinate their unvaccinated children and (4) a modified 5C scale tailored to determine parents' confidence, complacency, constraints, calculation and collective responsibility with regard to COVID-19 vaccination.

Results This study included 414 parents (median age=37 years; mothers=62%). COVID-19 vaccination rates for children in the age groups 12–17 years and 5–11 years were 72.5% and 30.1%, respectively. Transient adverse events following immunisation were reported by 32.7% of parents. Of parents with unvaccinated children aged 12–17 years, only 35% intended to vaccinate them. The majority of parents were not willing to vaccinate their children below 11 years of age. Parents with a self-reported positive history of COVID-19 disease (OR=2.531, p=0.016), and confident in the vaccine's safety and efficacy (OR=1.968, p=0.010), were more inclined to vaccinate their 5–11 years. In terms of vaccination of children below 5 years, confidence in the vaccine (OR=2.942, p=0.003) and a sense of collective responsibility were positive predictors (OR=2.260, p=0.035), while calculation was identified as a negative predictor of parents' intention to vaccinate their under 5 years (OR=0.421, p=0.018).

Conclusion CVH was significantly higher among parents of children aged 5–11 years and children younger than 5 years old. Priority should be given by health authorities to address parental concerns about vaccines and ensure that parents understand the significance of vaccination in protecting their children, to increase vaccination rates. This is because hesitancy towards one specific vaccine can negatively impact hesitancy rates in general.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Uptake of COVID-19 vaccination among children and parents' experiences with the vaccine were studied (motivators for parents to vaccinate children and their experience with postvaccination adverse events).
⇒ We also examined the psychological antecedents of COVID-19 vaccination (confidence, complacency, constraints, calculation and collective responsibility) and their association with parental intention to vaccinate children.
⇒ Study outcomes were measured using a validated Urdu-language instrument.
⇒ As the data were collected from one city, Lahore, the second largest city in Pakistan, our findings may not be easily generalisable to the broader context.
⇒ We used convenient sampling to recruit study participants, therefore, disadvantages associated with this non-probability sampling method cannot be disregarded (eg, selection bias and over-representation or under-representation of populations).

INTRODUCTION

The COVID-19 pandemic has had an appreciable impact on morbidity, mortality and costs.[1–5] Alongside this, lockdown measures had severely disrupted routine immunisation

programmes, resulting in an appreciable impact on future morbidity and mortality across countries, including Pakistan.[6–11] These disruptions are particularly concerning in Pakistan as they further exacerbated issues with routine immunisation programmes, especially among children currently living in urban slums.[12] Vaccines are known as an effective strategy to prevent infectious diseases, and therefore, reduce morbidity and mortality among all age groups, saving millions of lives annually.[13–16] It has also been reported that if low-income and middle-income countries (LMICs) had similar early access to COVID-19 vaccines as high-income countries, an appreciable number of deaths could have been averted.[17 18] This further highlights the need to ensure vaccine equity across countries, as well as ensure their maximum uptake once available, to save lives within LMICs.

There have been concerns with vaccination programmes over the years fueled by misinformation. The discredited study of Wakefield, published in 1998, suggesting a link between the combined measles, mumps and rubella vaccine and autism, still has an impact today, with recent publications documenting a continued decline in measles vaccination coverage rates alongside increased rates of cases of measles.[19–22] There have also been concerns that the polio vaccine causes AIDS, sterility and cancer, with this misinformation, alongside concerns with the practices of some Western pharmaceutical companies, impacting its uptake. These issues and concerns have resulted in boycotts of the vaccine across Africa and beyond.[23 24] This may help explain why polio is still endemic in Pakistan; however, considerable strides have been made in recent years to eradicate polio in Pakistan with the number of cases dropping from approximately 20 000 per year in the early 1990s to just 8 cases in 2018.[25 26]

The persistent misinformation about vaccines on social media and other platforms has led to a decline in parental demand for childhood immunisation, adversely affecting malaria and other infectious disease vaccination initiatives.[27 28] These issues and challenges are concerning if they subsequently impact COVID-19 vaccination rates.[1–5] Despite evidence of the safety and efficacy of COVID-19 vaccines, global uptake remains unsatisfactory due to misinformation.[29–36] Initial vaccination campaigns primarily targeted adults 18 years and older. Since the roll-out of COVID-19 vaccination for children, there are concerns about the uptake of these vaccines, heightened by questions surrounding their effectiveness and safety, along with a lack of information.[37–44] These issues need to be addressed going forward as children can contribute significantly to the spread of COVID-19, similar to other diseases caused by respiratory viruses.[41 42 45] In addition, children and adolescents, particularly in LMICs, account for a large proportion of a country's population,[46] enhanced by higher fertility rates in LMICs.[40] Consequently, vaccination coverage in this group is increasingly important for successful immunisation programmes within countries.[46]

The vaccination of children was not prioritised once COVID-19 vaccines initially became available, with initial prioritisation given to the elderly and front-line healthcare workers (HCWs).[47–49] However, this has been changing with increased evidence of the safety and efficacy of COVID-19 vaccines in children, and COVID-19 vaccines becoming more readily available. Alongside this, increasing recognition that mortality rates are typically higher among children admitted to hospital with COVID-19 in LMICs and subsequently transferred to intensive care units,[50–52] which needs to be avoided where possible.

Parental vaccine hesitancy is termed as a delay in the acceptance or refusal of vaccines for their children despite the availability of vaccination services.[38 39 53] The reluctance or refusal of parents to vaccinate their children may result in them being at risk of acquiring vaccine-preventable diseases.[40 42] The most important factors influencing the decision-making regarding COVID-19 childhood vaccination are parents' knowledge and attitudes, especially around key information areas, including perceptions of a very low risk of severe disease among children coupled with a lack of knowledge that children are often asymptomatic carriers.[54] Limited knowledge will ultimately result in decreased acceptance of vaccination.[40 55 56] Alongside this, parents' concerns regarding the safety of COVID-19 vaccines for children are a leading cause of vaccine hesitancy.[44 57] Not surprisingly, other predominant determinants reported to play a key role in parental vaccine hesitancy include social, cognitive and contextual factors.[40 57 58]

In Pakistan, even before the COVID-19 pandemic, parental vaccine hesitancy was prevalent.[59 60] Pakistan had been rated very high among the list of countries with the greatest proportion of unvaccinated children.[61] Confidence in vaccines has been waning since the start of the COVID-19 pandemic, with only 64% of the population in Pakistan perceiving that vaccines are important for children.[62] Since parents in Pakistan are principally responsible for deciding on vaccine uptake for their children, it is imperative to ascertain their acceptance of the COVID-19 vaccine and potential factors associated with vaccine hesitancy, which could include issues regarding vaccine effectiveness and safety. At present, COVID-19 vaccines have been offered at no cost to all children aged 5 years and above following the instigation of the vaccination campaign among children older than 5 years in September 2022.[63 64] Providing the vaccines free-of-charge is important given issues of affordability in Pakistan,[65] with constraints due to challenges of affordability impacting on vaccine hesitancy across countries.[66] Having said this, there is still appreciable vaccine hesitancy among people from different age groups and walks of life.[26 67–69] We recently conducted a study in Pakistan assessing the awareness and practices among parents towards vaccinating their children aged 5–18 years against COVID-19.[47] The findings revealed that parental knowledge and practices towards COVID-19 vaccination were far from satisfactory.

Similarly, Hussain *et al* also noted knowledge deficits and lack of supporting proof to be the main reasons for poor COVID-19 vaccine acceptance.[70] An electronic survey conducted by Rehman *et al*[71] showed that although 61.8% of parents were willing to vaccinate their children for protection against COVID-19, there were many fears and safety concerns related to the immunisation.

At the time of this study, COVID-19 vaccines have been offered to children aged 5 years and above and some parents have vaccinated their children against COVID-19 in Pakistan; however, there is a scarcity of published data regarding COVID-19 vaccine uptake in children and parents' experience with COVID-19 vaccines. Moreover, data are also limited regarding parents' intention to vaccinate their unvaccinated children aged 5–17 years, as well as children under the age of 5 years, which is important given the recent emergence and spread of a new variant of COVID-19 (JN1) in the country.[72 73] In view of this, our objective for this study was to address this continuing information gap regarding vaccine hesitancy among parents by investigating the experiences of parents who had vaccinated their children against COVID-19 as well as key factors that contributed to vaccine hesitancy among parents who still had unvaccinated children. We are aware that there had been a number of studies, including systematic reviews, that investigated COVID-19 hesitancy rates among parents for their children.[38–40 42 43 47 54 70 71 74] However, we wanted to build on these studies given, as mentioned, existing concerns with vaccine hesitancy in Pakistan and heightened concerns of large-scale outbreaks from newer variants.

MATERIALS AND METHODS

Study design, location and target population

This cross-sectional survey was undertaken among the residents of Lahore, the second largest metropolis in Pakistan. Punjab province, and within it, Lahore, was chosen for this project as this province is the most populous in Pakistan. Furthermore, our previous study was also conducted in Punjab Province, hence providing baseline data.[47]

Sample estimation

The sample size for the present study was calculated using the proportional formula on the OpenEpi online sample size calculator (https://www.openepi.com). With a 95% confidence level, 5% margin of error, 50% response distribution and population size of 1 000 000, the calculated sample size was 384 parents. We increased this number by 10%, aiming to recruit 422 participants, to account for any incomplete data.

Data collection instrument

Development

A self-administered questionnaire (online supplemental file 1), completed anonymously, was developed by the principal investigators (MS and THM) from published literature regarding parental vaccine hesitancy.[75–79]

We adapted the 5C scale, which is based on the five psychological antecedents of vaccination, namely confidence, complacency, constraints, calculation and collective responsibility,[75] to capture vaccination behaviour, specifically focusing on these psychological factors that influence vaccination decision-making. The initial draft of the questionnaire was thoroughly reviewed by a panel of five experts in the field of health sciences. The panel recommended simplifying the response options for the questions assessing the 5C's of COVID-19 vaccination by changing from a 7-point Likert scale to a 5-point Likert scale, that is, 'strongly disagree' to 'strongly agree'. A similar Likert scale for the 5C scale has also been used by Deng *et al* and Dass *et al* to examine COVID-19 vaccine hesitancy.[78 79] The panel further recommended some minor changes to improve the wording of the questions. The revised draft was re-evaluated by the panel and subsequently approved for translation into the Urdu language.

Translation and validation

The questionnaire was translated into the Urdu language using a forward-back translation method. Content validation of the Urdu version of questionnaire was assessed by brief cognitive interviews among seven individuals recruited using convenience sampling. The Content Validity Index (CVI) on the clarity and comprehensibility was determined by reviewing the frequency of responses (yes/no). The CVI reached 1 for all the items, indicating adequate content validity. The internal consistency of the modified 5C scale was determined by examining Cronbach's alpha using data from the first 50 responses. The results indicated sufficient internal consistency of the instrument, with Cronbach's alpha >0.7 for all five domains of the scale.

Sections of the data collection instrument

The questionnaire consisted of four sections for collecting the necessary data to address the study objectives:

- Section-I: The aims and objectives, and nature of the study were explained. In addition, it contained a written informed consent statement for participation in the study.
- Section-II: Demographic details of the parents participating in the study, including age, sex, education, COVID-19 status, COVID-19 vaccination status, occupation, number of children and details of children below 18 years of age.
- Section-III: Information about COVID-19 vaccine uptake in children aged 5–17 years, COVID-19 vaccine details, adverse events following immunisation (AEFI) and reasons for COVID-19 vaccination. In addition, parents who had unvaccinated children aged 5–17 years, as well as children under the age of 5 years, were asked about their willingness to vaccinate their children against COVID-19.

- Section-IV: This section assessed the five psychological antecedents (domains) of COVID-19 vaccination. It comprised a modified 5C scale tailored to determine parents' confidence, complacency, constraints, calculation and collective responsibility with regard to childhood COVID-19 vaccination.[75] The scale had 15 items covering the 5C domains, with each domain covered by three items. The responses were recorded on a 5-point Likert scale ('1' strongly disagree; '2' disagree; '3' neutral; '4' agree; '5' strongly agree). The 5C scale does not have an aggregate score providing the sample's absolute vaccine hesitancy, rather, scores were computed for each domain separately. There was one negatively worded item in the collective responsibility domain. This item was subsequently reverse coded ('5' strongly disagree to '1' strongly agree) during data entry. Average scores of items within each 5C domain were calculated, with a higher score indicating stronger agreement with the corresponding domain.

Data collection team and recruitment of participants

The data collection team comprised five final-year doctor of pharmacy students. Data collection training was conducted for the team mid-February 2023, followed by mock practice sessions during the last week of February, to identify and resolve any issues related to the data collection. Data collection took place between March 2023 and April 2023, using a convenience sampling approach to recruit participants from public places in Lahore, where one would commonly find parents, such as waiting areas at educational institutes (public and private schools, colleges and universities) and shopping malls.[80–82] The inclusion criteria for participation were (1) parents; (2) having at least one child ≤17 years old; (3) being able to understand and speak Urdu language (Pakistan's national language) and (4) consenting to participation in the study. On agreement to participate, participants signed informed consent, and the study questionnaire was administered. If requested by respondents, the data collection team provided assistance with the completion of the questionnaire. Furthermore, illiterate individuals were interviewed by the data collectors.

Data management and statistical analysis

The data were entered into Microsoft Excel and exported to IBM SPSS V.25 after coding and cleaning. Normality of the continuous data was determined using the Lilliefors-corrected Shapiro-Wilk test. In addition, histograms were inspected to assess the normality of data distribution. As a result, Likert scale ranked data for computing vaccine hesitancy scores within the 5C domains were summarised as medians with IQR whereas frequencies and percentages were used to summarise categorical data. Continuous data were compared using Mann-Whiteny U test or Kruskal-Wallis H test where appropriate. The χ^2 test or the Fisher's exact test was used to compare categorical variables, as applicable. Factors associated with parents' intention to vaccinate their unvaccinated children were determined in a binary logistic regression analysis (dependent variable: parental intention to vaccinate; method=enter). The cut-off criterion for variable selection for the multivariate analysis was $p<0.25$ in the univariate analysis. A $p<0.05$ was considered statistically significant.

Table 1 Demographic characteristics of the study population (N=414)

Variable	N (%)
Respondent	
Mother	257 (62.1)
Father	157 (37.9)
Age (median (IQR); years)	37 (10)
<30 years	76 (18.4)
31–40 years	217 (52.5)
>40 years	120 (29.1)
Education	
Illiterate/religious education only	18 (4.3)
Primary school	25 (6.0)
Middle school	35 (8.5)
Secondary-higher secondary school	90 (21.7)
Tertiary education (graduated)	246 (59.4)
Parent's vaccination status	
Unvaccinated	54 (13.0)
Partially immunised*	40 (9.7)
Fully immunised†	320 (77.3)
Suffered from COVID-19 during the pandemic	
Yes	110 (26.6)
No	304 (73.4)
No. of children	
1	53 (12.8)
2–3	248 (59.9)
>3	113 (27.3)
Children aged 12–17 years	
Yes	229 (55.3)
No	185 (44.7)
Children aged 5–11 years	
Yes	296 (71.5)
No	118 (28.5)
Children aged less than 5 years	
Yes	194 (46.9)
No	220 (53.1)

*A person who took only one dose of the vaccine that requires two doses to complete the vaccination series.
†A person who has received all the recommended COVID-19 vaccine doses.

Patient and public involvement

No patients or members of the public were involved in the design, execution and/or communication of the study outcomes.

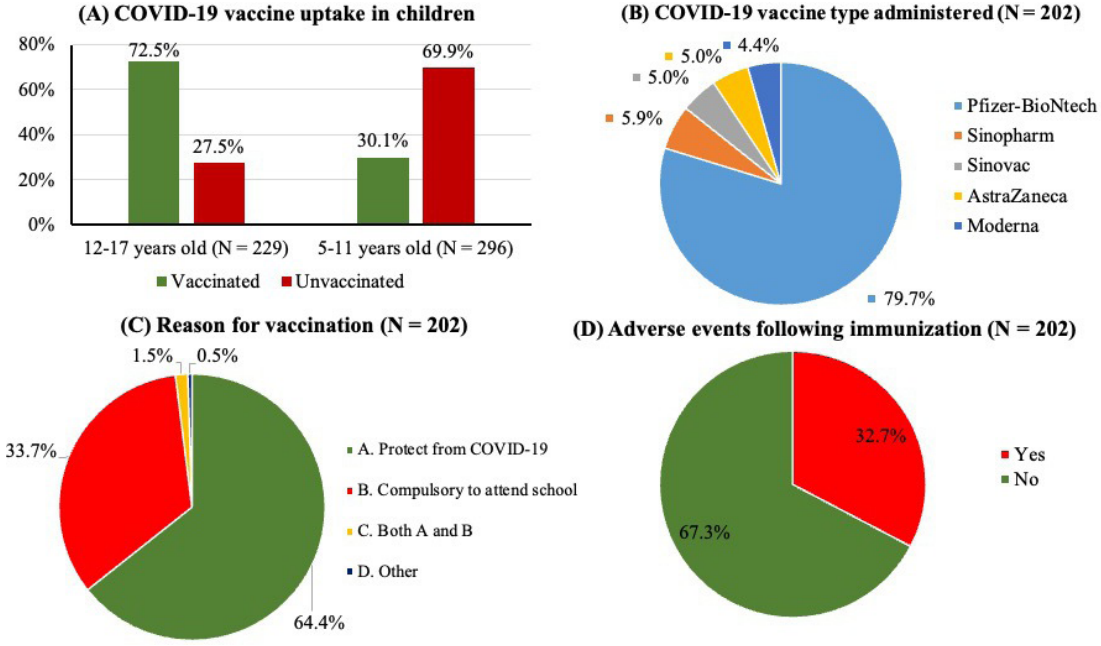

Figure 1 COVID-19 vaccine uptake in children (A), type of COVID-19 vaccine administered (B), reasons for the vaccination (C) and frequency of adverse events following COVID-19 vaccine (D).

RESULTS

Demographic characteristics of the sample

A total of 584 parents were approached by the research team, of whom 511 consented to participate in the study (participation rate=87.5%). After data cleaning and removing incomplete records, the final sample for analysis consisted of 414 participants (mother 62.1%; father 37.9%). Demographic details of the study participants are given in table 1.

The median age of the sample was 37 (IQR 10) years, with the majority being in the 31–40 years' age group. In terms of education, most participants were categorised as graduates with a tertiary qualification (59.4%), followed by secondary/higher secondary (21.7%) and middle education (8.5%). Regarding parents' immunisation status, the majority of participants (320 (77.3%)) were fully immunised, as they had received all scheduled recommended COVID-19 vaccine doses, of whom 56 individuals had also received an additional COVID-19 booster dose.

Overall, 110 (26.6%) individuals reported that they suffered from COVID-19 during the pandemic, including 92 fully immunised and 16 partially immunised participants. Of those either fully or partially immunised, the majority self-reported that they had contracted the disease prior to vaccination (71.3%). The majority of parents had 2–3 children (55.3% with children aged 12–17 years; 71.5% with children aged 5–11 years; 46.9% had under 5-year-old children).

COVID-19 vaccination uptake in children aged 5–17 years

As shown in figure 1A, 72.5% and 30.1% of children between the ages of 12–17 years and 5–11 years, respectively, had been immunised against COVID-19. The majority of vaccinated children (79.7%) had received the Pfizer-BioNtech COVID-19 vaccine (figure 1B). The most prevalent reasons for vaccination were 'I want to protect my child from COVID-19' (64.4%), followed by 'it was made compulsory to attend the school' (33.7%) (figure 1C).

With regard to AEFI, 32.7% reported that their children had suffered some transient adverse events following COVID-19 vaccination (figure 1D). The most common adverse events were fever, injection site pain, myalgia-arthralgia and sore throat (figure 2A). Encouragingly,

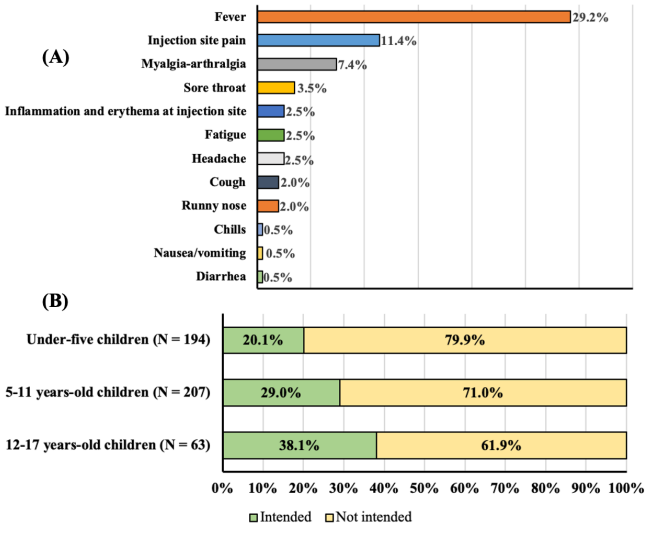

Figure 2 (A) Profile of adverse events following immunisation reported in children after receiving the COVID-19 vaccine (N=202) and (B) parents' intention to vaccinate their unvaccinated children for COVID-19.

none of the study participants reported any serious AEFI with the COVID-19 vaccine experienced by their children.

Parents' intention to vaccinate their unvaccinated children

Figure 2B depicts parents' willingness to vaccinate their children against COVID-19. Of the 63 parents who had unvaccinated children aged 12–17 years, only 38.1% intended to vaccinate them. The majority of parents with unvaccinated children aged 5–11 years were not willing to vaccinate them against COVID-19, as well as those with children under the age of 5 years.

5C psychological antecedents of COVID-19 vaccination

Responses to the 5C statements on COVID-19 vaccination of parents who had at least one unvaccinated child (N=305) were used to compute scores for each domain of the scale. The overall median score for confidence, complacency, constraints, calculation and collective responsibility domains were 3 (IQR=2), 3.3 (IQR=1.7), 2.7 (IQR=1.3), 4 (IQR=1) and 3 (IQR=1.7), respectively. Online supplemental table S1 shows further details on parents' level of agreement with the items of the 5C scale.

Parents' confidence in the COVID-19 vaccine

Our analysis showed that the majority of parents had doubts about the safety and effectiveness of COVID-19 vaccines in children (COVID-19 vaccine is safe for my child=37%; COVID-19 vaccines are effective=36.8%). Only 45.6% were confident that what the government/public health authorities decide is in the best interest of their children when it comes to childhood COVID-19 immunisation. As shown in online supplemental table S1, greater confidence in the vaccine safety and effectiveness was positively associated with parental intention to vaccinate their children against COVID-19.

Complacency

As also shown in online supplemental table S1, 43.6% of parents believed COVID-19 vaccination is unnecessary for children as the disease is not common anymore, 19.0% chose a neutral response to this item whereas only 37.4% disagreed with the statement. Overall, 44.6% of parents considered their child's immune system as good enough to protect against SARS-CoV-2 whereas 45.3% reported that children do not need to get vaccinated as they are not at higher risk of COVID-19. As expected, parents with a low score within this domain were more inclined towards vaccinating children against COVID-19 within all three age groups (online supplemental table S1).

Constraints

Approximately 29% of the parents reported that everyday stress prevents them from getting their children vaccinated for COVID-19, 56.4% did not find it inconvenient to get their child vaccinated for COVID-19 whereas 23.4% reported that visiting a COVID-19 vaccination centre with their children makes them uncomfortable. As a result, preventing them from getting their children vaccinated against the disease. No significant association was observed between the score for the constraints domain and parental intention to vaccinate their children aged 12–17 years and 5–11 years. However, for the under 5-year-old age group, those unwilling to vaccinate reported greater constraints (online supplemental table S1).

Calculation

The majority of parents reported that they do weigh the benefits against the risks of the vaccine (adverse effects) before getting their children vaccinated, and 73.8% questioned the usefulness of the vaccine with each and every childhood vaccination. Similarly, a significant proportion of parents (75.7%) reported that it was important for them to fully understand key aspects of COVID-19 vaccines before getting their children vaccinated against COVID-19. As shown in online supplemental table S1, there was no significant association between the calculation-related score and parental intention to vaccinate children aged 12–17 years and 5–11 years. However, those unwilling to vaccinate their under 5-year-old children achieved a higher score in the calculation domain (online supplemental table S1).

Collective responsibility

While 57.1% of parents reported that vaccination is a collective action to prevent the spread of COVID-19, 42.9% wanted to get their children vaccinated because it would protect not only them but also others from the disease. However, nearly 40% of parents believed their children did not need to get the COVID-19 vaccine as the majority of the population was already vaccinated against the disease. Of equal concern is that 21% chose a neutral response for this statement. As expected, a greater sense of collective responsibility was positively associated with the intention to vaccinate children for COVID-19 (online supplemental table S1).

Association between demographics characteristics and parental intention to vaccinate

Table 2 shows the association between demographic characteristics and parental intention to vaccinate their unvaccinated children for COVID-19. Those fully immunised against COVID-19 were significantly in favour of getting their children vaccinated for COVID-19 than the others ($p<0.05$ for all three age groups of children) (table 2). In addition, a significantly greater proportion of parents with a self-reported positive history of COVID-19 disease, were in favour of getting their children aged 5–11 years vaccinated for COVID-19 ($p=0.035$). However, a similar association was not observed among children aged 12–17 years and under 5 years (table 2).

Determinants of parent's intention to vaccinate their children for COVID-19

We performed a series of binary logistics regression analysis (method: enter; dependent variable: intention to vaccinate) to determine parental intention to vaccinate their unvaccinated children within different age groups.

Table 2 Association of demographics characteristics and parental intention to vaccinate their unvaccinated children

Variables N (%)	Parents' intention to vaccinate children		
	Intended	Not intended	Sig.
12–17-year-old children (N=63)			
Parent			0.188
Mother	17 (70.8)	20 (51.3)	
Father	7 (29.2)	19 (48.7)	
Age			0.115
<40 years	21 (53.8)	18 (75.0)	
>40 years	18 (46.2)	16 (25.0)	
Education			0.377
Primary or less	4 (16.7)	5 (12.8)	
Middle	3 (12.5)	4 (10.3)	
Secondary-higher secondary	4 (16.7)	8 (20.5)	
Graduation or above	13 (54.2)	22 (56.4)	
Parent's vaccination status			0.035
Unvaccinated	2 (8.3)	14 (35.9)	
Partially immunised	3 (12.5)	5 (12.8)	
Fully immunised	19 (79.2)	20 (51.3)	
Self-reported COVID-19 status			0.570
No	15 (62.5)	28 (71.8)	
Yes	9 (37.5)	11 (62.5)	
5–11-year-old children (N=207)			
Parent			0.639
Mother	39 (65.0)	90 (61.2)	
Father	21 (35.0)	57 (38.8)	
Age			0.320
<30 years	4 (6.7)	20 (13.6)	
31–40 years	38 (63.3)	91 (61.9)	
>40 years	18 (30.0)	36 (24.5)	
Education			0.054
Primary or less	5 (8.3)	19 (12.9)	
Middle	2 (3.3)	14 (9.5)	
Secondary-higher secondary	9 (15.0)	36 (24.5)	
Graduation or above	44 (73.3)	78 (53.1)	
Parent's vaccination status			<0.001
Unvaccinated	1 (1.7)	41 (27.9)	
Partially immunised	3 (5.0)	24 (16.3)	
Fully immunised	56 (93.3)	82 (55.8)	
Self-reported COVID-19 status			0.035
No	34 (56.7)	106 (72.1)	
Yes	26 (43.3)	41 (27.9)	
Under 5-year-old children (N=194)			
Parent			0.144
Mother	19 (48.7)	97 (62.6)	
Father	20 (51.3)	58 (37.4)	
Age			0.797
<30 years	47 (30.3)	14 (35.9)	
31–40 years	87 (56.1)	20 (51.3)	
>40 years	21 (13.5)	5 (12.8)	
Education			0.985
Primary or less	4 (10.3)	15 (9.7)	
Middle	1 (2.6)	7 (4.5)	
Secondary-higher secondary	6 (15.4)	28 (18.1)	
Graduation or above	28 (71.8)	105 (67.7)	
Parent's vaccination status			0.003
Unvaccinated	0 (0.0)	25 (16.1)	
Partially immunised	1 (2.6)	18 (11.6)	
Fully immunised	38 (97.4)	112 (72.3)	
Self-reported COVID-19 status			1.000
No	28 (71.8)	111 (71.6)	
Yes	11 (28.2)	44 (28.4)	

Predictors of parental intention to children aged 12–17 years

10 variables (demographic variables and 5C domains) were subjected to univariate analysis. Of these, six variables were selected for a multivariate analysis ($p<0.25$; covariates: respondent, age, vaccination status, confidence in vaccines, complacency and collective responsibility). Our multivariate analysis to determine predictors of parental intention to vaccinate their children aged 12–17 years did not yield any statistically significant predictors ($p>0.05$).

Predictors of parental intention to vaccinate children aged 5–11 years

Of the 10 variables initially subjected to the univariate analysis, 8 met the criteria for inclusion in the multivariate analysis to determine predictors of parental intention to vaccinate their children aged 5–11 years for COVID-19 (respondent, age, education, history of COVID-19 disease, confidence, complacency, calculation and collective responsibility). Parents' vaccination status was excluded from the analysis due to having the value '1' (intended to vaccinate) gathering on one extreme and the value '0' (not intended) on the other extreme of this variable.

Our multivariable-adjusted logistic regression model was statistically significant (χ^2 (10)=57.439, $p<0.001$. It explained 34.6% variance (Nagelkerke R^2) and correctly classified 76.8% of cases. Furthermore, the findings of the goodness-of-fit test showed adequate predictive capacity

of the model (Hosmer-Lameshow test: χ^2 (8)=10.278, p=0.246). Having confidence in the safety and effectiveness of the COVID-19 vaccines (OR=1.968, p=0.010) and a self-reported positive history of COVID-19 disease (OR=2.531, p=0.016) were both significant positive predictors of parents' intention to vaccinate their children aged 5–11 years.

Predictors of parental intention to vaccinate under 5-year-old children

Of the 10 variables subjected to the univariate analysis, 6 met the criteria for inclusion in the multivariate analysis to determine predictors of parental intention to vaccinate their under 5-year-old children for COVID-19 (respondents, confidence, complacency, constraints, calculation and collective responsibility). Parents' vaccination status was not included in the analysis due to a problem of quasi-complete separation. Our regression model to assess determinants of parental intention to vaccinate under 5-year-old children against COVID-19 was statistically significant (χ^2 (6)=79.544, p<0.001). It explained 53.1% variance (Nagelkerke R^2) and correctly classified 85.6% of the cases. Findings of the goodness-of-fit test revealed our model predicted values that were not significantly different from what we observed (Hosmer-Lameshow test: χ^2 (8)=6.808, p=0.557). In the multivariable adjusted analysis, greater confidence in the COVID-19 vaccine (OR=2.942, p=0.003) and sense of collective responsibility (OR=2.260, p=0.035) were positive predictors of the intention to vaccinate under 5-year-old children for COVID-19, whereas calculation was identified as a negative predictor of parental intention to vaccinate their children in this age group (OR=0.421, p=0.018).

DISCUSSION

The present study, arguably one of its kind in Pakistan, examined the uptake of COVID-19 vaccination among children, delving into parents' experiences with the vaccine (reasons for vaccinating children and AEFI experienced). In addition, exploring parents' general concerns, attitudes and hesitancy towards vaccination against COVID-19 for their children based on the age of their children. This is important in Pakistan given previous evidence of hesitancy with other vaccines, with Pakistan currently having an appreciable proportion of unvaccinated children.[62] Alongside this, ongoing concerns with misleading narratives enhancing vaccine hesitancy rates among parents.[83–85]

The childhood COVID-19 vaccination rate of 72.5% for children aged 12–17 years, but only 30.1% for children aged 5–11 years is a concern. However, similar results were seen in a study conducted among eight countries of the Eastern Mediterranean Region, where COVID-19 childhood vaccination coverage ranged from 17.9% to 49.2%.[44] Our findings are also consistent with the results of other studies in which parents of young children expressed appreciable concerns regarding the adverse effects of COVID-19 vaccines.[71 86–88]

Our analysis revealed that a significant proportion of parents who did not vaccinate their children had safety concerns, similar to a recent systematic review.[57] This corroborates the findings that among children and adolescents, the safety and effectiveness of vaccines are key reasons for hesitancy,[89] similar to other studies.[70 71 86–88] Interestingly though in our study, only 34% of children experienced transient adverse events following COVID-19 immunisation. Fever, pain at the injection site and muscle/joint pain were the common symptoms experienced by children after vaccination. These results suggest a satisfactory safety profile of the COVID-19 vaccines among children aged ≥5 years. Similarly, Zaufishan *et al* reported only a mild nature of side effects among children aged 12–18 years following COVID-19 vaccination, including pain at the injection site, fever and muscle pain.[89] Hu *et al* also reported that the Pfizer-BioNTech vaccine (BNT162b2) is safe for children aged ≥5 years, but myocarditis and pericarditis should be monitored following the administration of vaccines in this age group.[90] The risks of myocarditis or pericarditis following mRNA vaccines have also been reported in other studies, particularly among younger males aged 12–29 years.[91–93] However, most studies that have investigated the safety profile of COVID-19 vaccines among children have only included those, aged >5 years.[90 94 95] Our results lacked safety data on vaccines for children younger than 5 years as vaccination for this age group was not rolled out at the time of this study. Having said this, published studies appear to confirm the safety of the Pfizer and Moderna vaccines for children aged 6 months to 5 years.[96] The review of V-safe and Vaccine Adverse Event Reporting System (VAERS) data showed mild to moderate side effects among children younger than 5 years, including irritability, crying, sleepiness, fever, pain at injection site and fever.[97] Bearing in mind that the latter is based on spontaneous reporting, with causal links to vaccination not confirmed, these findings suggest a satisfactory safety profile of mRNA vaccines among children younger than 5 years, and consistent with reports from clinical trials. These spontaneous reporting systems are useful to detect unusual patterns of reported AEFI,[98] which might indicate a possible safety signal for a vaccine, which should then be further investigated. Actively disseminating real-world data should help to further reassure parents regarding the safety of childhood COVID-19 vaccination and help to build confidence in vaccines and mitigate vaccine hesitancy.[99] This is because, as mentioned, studies have shown that when parents believe in the safety profile of vaccines, they have higher odds of vaccinating their children against COVID-19.[100]

The majority of parents reported that they had vaccinated their children to protect them from SARS-CoV-2 infection. These findings are significant as they indicate that parents perceive vaccines as a means of safeguarding their children from the disease. Approximately one-third

of parents in our study reported vaccinating their children to adhere to school regulations, as certain schools in Pakistan permitted only vaccinated children to attend classes, consistent with practices in other countries.[101] Consequently, health authorities in Pakistan must focus on educating parents and implementing vaccine mandates for children to alleviate concerns, as ethical dilemmas may arise from compulsory vaccination programmes.[102] One of the reasons for this is because there appears to be a strong correlation in Pakistan between parental vaccine hesitancy and the belief in vaccine-related conspiracy theories.[103]

This study also evaluated the intention of parents to vaccinate their unvaccinated children against COVID-19. Unfortunately, the majority of parents who currently had not vaccinated their children did not intend to do so in future. The vaccination intention rates were 20.1%, 29% and 38.1% among parents with children aged <5 years, 5–11 years and 12–17 years, respectively. Of the five psychological antecedents of vaccination, the median scores for constraints, which included both parents who intended to, and those with no intention to vaccinate their children in future, were lowest (2.7 (IQR 1.3)). However, in the bivariate analysis, higher scores in terms of constraints were associated with parents who were unwilling to vaccinate children under the age of 5 years ($p<0.001$). A potential way forward is to administer the COVID-19 vaccine to children at their homes. Pakistan has extensive experience with door-to-door immunisation programmes for polio, and identical strategies can be used for childhood COVID-19 vaccination. We will be exploring this in the future.

Another concern was the low score for collective responsibility in our study, with 40% of parents believing their children did not require vaccination since the majority of the population had already been vaccinated against COVID-19. Encouragingly, parents exhibiting an increased sense of collective responsibility demonstrated less vaccine hesitancy. Collective responsibility has emerged as a significant predictor of COVID-19 vaccine acceptance in numerous global studies.[66 104–106] This suggests a need for parental education programmes encouraging collective responsibility going forward in Pakistan to address current hesitancy rates.

Logistic regression analysis revealed that parents having confidence in the safety and efficacy of COVID-19 vaccines were more likely to vaccinate their over 5-year-old children. These results corroborate the findings of other studies in which parents who received COVID-19 vaccines were seven times more likely to vaccinate their children.[100 107 108] Likewise, parents' confidence in COVID-19 vaccines has been identified as an important facilitator of childhood vaccination in multiple studies,[109–111] as well as in a recent systematic review.[57] Interestingly, confidence in COVID-19 vaccines, and a greater sense of collective responsibility, were also identified as a significant predictor of vaccination intent among parents of children younger than 5 years old.

The psychological antecedent calculation (ie, calculation of the risk–benefit profile of vaccines) was found to be negatively associated with parents' vaccination intention for children younger than 5 years, similar to other studies.[104] This finding may be related to the limited available data regarding the effectiveness and safety of COVID-19 vaccines in young children, and young children are reported to be at lower risk of severe COVID-19 disease.[112] The availability of more real-world data on the safety and effectiveness of COVID-19 vaccines, combined with educational initiatives surrounding collective responsibility, may help with enhancing parental acceptance in the future. Educational efforts must also address increasing misinformation and misleading claims currently promulgated in social media.[31 113 114] Feedback from parents who had vaccinated their children has been ranked a major driver of childhood vaccination in various studies.[100] Involvement of paediatricians or other HCWs can additionally address the calculation factor among parents, thereby increasing vaccination rates among children. Prior to implementing this initiative, however, there is a need to address any vaccine hesitancy among HCWs. This is because numerous studies have revealed vaccine hesitancy is also present among this key group.[115–118] However, this is not always the case among HCWs in LMICs.[119 120]

Study limitations

We recognise our study's limitations. The small sample size, convenience sampling, recall bias for adverse effects, potential generalisability of the findings and the time frame of data collection should be taken into consideration when interpreting the results. It is important to note that our study did not capture the vaccination rate among children younger than 5 years as the vaccination for this age group was not rolled out at the time of data collection. Future data collection may result in a fluctuation in the overall vaccination rate among children. Furthermore, there is a greater proportion of mothers in our study, hence vaccination intent and hesitancy may vary if more data were collected from fathers. Lastly, we are aware that the data was collected from one city, Lahore, although the second largest city in Pakistan. Consequently, our findings may not be easily generalised to the entire Pakistani population. However, despite these limitations, the present study findings and the implications are significant as this study is the first of its kind to provide an elaboration of the safety profile of COVID-19 vaccination among children in Pakistan, alongside factors related to intention and barriers to childhood COVID-19 vaccination. In addition, potential psychological antecedents of paediatric vaccination among parents.

Implications for future research and practice

Given the adequate safety profile of COVID-19 vaccines among children, health authorities should invest in nationwide campaigns emphasising the importance of COVID-19 vaccination and providing safety assurance

to reduce parental hesitancy. This can be achieved by engaging HCWs, in particular, paediatricians, and community influencers to counteract misinformation including conspiracy theories regarding the vaccines. Moreover, feedback from parents who had positive experiences after vaccinating their children should also be used as a tool in this regard. As a considerable number of study participants cited inconvenience as a barrier, initiatives including door-to-door vaccination campaigns, inspired by polio immunisation strategies, could be considered when vaccines are available for current and future pandemics. Since data in this study came predominantly from the Lahore metropolis, large-scale studies among urban as well rural population across Pakistan are also warranted to provide a more comprehensive picture. Furthermore, future investigations should ensure a balanced representation from both mothers and fathers.

Conclusions

Our study revealed unsatisfactory vaccination rates among children, particularly for those in the 5–11 years age group. Most parents vaccinate their kids for disease prevention or to comply with school requirements. However, parents of unvaccinated 5–11 years and under-5s showed significant COVID-19 vaccination hesitancy. Greater confidence in the safety and effectiveness of vaccines and a sense of collective responsibility are significantly linked with parents' vaccination intention. The calculation domain of the 5C model was negatively associated with parental vaccination intentions. Health authorities in Pakistan must prioritise addressing parental apprehensions concerning vaccines. Subsequently, ensure that parents fully understand the importance of vaccination for their children by using social media and other platforms for broad dissemination. These measures would enhance the vaccination rates for children in Pakistan and elsewhere.

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