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Strategies to decrease COVID-19 vaccine hesitancy for children

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Abstract

Objectives This study aims to understand acceptable strategies to enhance the COVID-19 vaccine uptake among mothers who have no intention to vaccinate their children.

Methods In a cross-sectional study, using an online survey in March 2021, we evaluated the variables within the Health Belief Model (severity, susceptibility, benefits, barriers and cues to action) along with parents' sociodemographic characteristics, previous COVID-19 infection, job loss due to COVID-19 pandemic and the presence of healthcare workers among the household. Total number of children in the household and their chronic health conditions were also assessed. Multivariable logistic regression was performed to evaluate the intention to vaccinate children against the COVID-19 and associations with other variables.

Key findings The survey response rate was 32.30% (595/1842). Most of the participants were White (72.1%), 31–40 years old (55.46%) and married or in a cohabiting relationship (90.25). Out of 595 mothers with 3–15 years old children, 38.32% had no intention to vaccinate their children. Top factors associated with intention were perceived susceptibility ($P = 0.002$), benefits ($P < 0.001$), barriers ($P < 0.001$), cues to action ($P < 0.001$) and the presence of healthcare workers in the household ($P = 0.032$). The main barriers were concerns about vaccine safety, efficacy and side effects. The strongest cue to action was enough information being provided followed by doctors' recommendations.

Conclusions Strategies to increase vaccination for children lie in the process of convincing parents with providing reliable information on the vaccine safety, efficacy and side effects by paediatricians and other healthcare providers.

Keywords COVID; vaccine; health belief model; children

Introduction

In January 2020, Coronavirus disease 2019 (COVID-19) was declared a Public Health Emergency of International Concern by the World Health Organization.[1] The main strategy against the COVID-19 pandemic was the invention of a new vaccine. The first vaccine received an emergency use authorization (EUA) from the Food and Drug Administration (FDA) in December 2020 followed by the initiation of the national vaccination.[2] While about 60.4% of the US adult population have been fully vaccinated by the end of July 2021, only 33% of 12–17 years old had received the COVID-19 vaccine during the same period, and 25% of parents stated that they will definitely not vaccinate their children.[3, 4]

With the emergence of the delta variant in the USA and the rapid spread of the new variant, vaccination of children is finding a more

critical role in the control of the pandemic.[5] Delta variant with a higher transmissibility and the ability to establish a higher viral load earlier during the course of infection has caused a dramatic drop in the Alpha variant infections from 67% in May 2021 to less than 3.0% in just 10 weeks.[5] Despite the high transmissibility and higher viral load, it seems that the COVID-19 vaccination has similar effectiveness against both Alpha and Delta variants.[6] However, there are still many individuals hesitant towards the COVID-19 vaccination.[4]

Early recognition of intention to vaccinate is a critical step towards the implementation of policies to enhance the COVID-19 vaccine uptake. However, little is known about the main concerns of parents, specifically mothers, who do or do not intend to have their children vaccinated. There is a lack of understanding on how mothers' characteristics such as their age and education, as well as their children's characteristics such as having chronic health conditions, affect their intention to consider the COVID-19 vaccine for their children. In addition, understanding the effect of previous COVID-19 infection and if this experience enhances the decision to vaccinate children has not been evaluated.

This study uses the Health Belief Model (HBM) as a framework to identify modifiable factors that could improve the vaccine uptake. The HBM is a social- and psychological-based health behaviour change model developed to explain and predict behaviours that are related to the uptake of health services.[7] The HBM model evaluates important components involved in the process of decision-making, including perceptions of disease severity, susceptibility to the disease, benefits of taking an action against the disease, barriers in front of the action and cues that may increase the probability of an action.[8]

The objective of this study is to identify factors associated with a higher intention to COVID-19 vaccination and to propose effective strategies that might help us enhance mothers' intention to vaccinate their children against COVID-19.

Methods

This study was a regional, cross-sectional, online survey of mothers. To be eligible for the study, participants had to be at least 18 years old and have at least one child between the ages of 3 and 15 years old. After considering informed consent, participants filled an online survey with no compensation or gifts. The study was evaluated and approved by the Institutional Review Board.

The survey was extensively advertised using online parental groups in urban and rural areas of Texas. Parental groups were found on Facebook, Instagram and WhatsApp. In addition, Harris County Department of Education distributed the link to the survey among parents of 3–5 years old children in Harris County district. Data collection started on 4 March 2021 and continued until 18 March 2021.

The HBM constructs were measured using items applied previously and modified to fit our study.[9] Several statements assessed perceived susceptibility (three items), perceived severity (three items), perceived benefits (two items), perceived barriers (five items), cues to action (four items) and intention (one item) (Supplementary Appendix 1). All constructs were measured on a 5-point Likert scale from strongly disagree (1) to strongly agree (5).

Participants' demographic characteristics obtained included age, race, marital status, residential area and educational level. We also collected information on whether any of the household members were healthcare providers, have gotten COVID-19 infection or have lost their jobs due to the pandemic. Children's characteristics were limited to the number of children in the household and whether they had any chronic health conditions.

The survey was tested for ease of use, response time and readability using pilot studies. The survey was tested by five mothers who met the inclusion criteria of the study. Based on the feedback, minimal changes were applied to the survey instrument to make it more user-friendly.

Mothers were divided into two groups based on their score for the intention construct. mothers with an intention score above 3 were categorized as having intention to vaccinate their child against COVID-19 and those with scores 3 and below were categorized as no intention for vaccination.

HBM constructs were developed by taking the average of individual items within each construct where a higher score meant a higher level of perception. The internal consistency for each construct was considered satisfactory if the Cronbach's alpha was greater than 0.7.[10] The convergent validity for each construct was confirmed by ensuring that the average variance extracted (AVE) was no less than 0.5.[10] The discriminant validity was assessed by comparing the square-root value of AVE with inter-construct correlation values.[10]

Descriptive statistics were calculated for all variables. Numbers and percentages were reported for categorical variables, while mean and standard deviation were used for continuous variables. Logistic regression and Mann–Whitney test were used to evaluate the statistical significance of categorical and continuous variables, respectively. Statistical significance was assessed at P-value <0.05.

To assess the variables associated with intention to vaccinate, univariable and multivariable logistic regressions were carried out. A purposeful selection process was utilized based on a univariable analysis for each variable. We based our multivariable analysis on the Wald test from logistic regression and a P-value cut-off point of 0.25.[11] The 0.25 value was used since the more traditional levels such as 0.05 may fail in identifying some important variables.[11]

Model discrimination was assessed using the area under the receiver operating characteristic (ROC) curve or c-statistic, and a c-statistic ≥0.7 indicated a good discrimination.[12] Model calibration was assessed by the Hosmer–Lemeshow test and a value greater than 0.05 indicated good calibration.[12]

Results

A total of 1842 people started the survey, and 595 responses were considered based on the inclusion criteria (response rate = 32.30%). Most respondents were 31–40 years old (55.46%), White (72.10%) and married or in a cohabiting relationship (90.25%). The characteristics of the final sample, comprised of 595 participants, are described in Table 1. Most of the participants had at least 4 years of college education (78.15%). More than one-third of mothers were living in households with at least one healthcare worker (36.47%). Overall, 17.98% of mothers indicated that at least one of the household members had lost their jobs during the pandemic and 19.16% of mothers indicated COVID-19 infection among the household. Many mothers (38.32%) had no intention to vaccinate, while 61.68% were intended to vaccinate their children against COVID-19.

After elimination of two items from the barriers construct regarding the affordability of the vaccine and difficulty towards scheduling for vaccination, the Cronbach's alpha for each of the HBM constructs was good (>0.7). The AVE values for the HBM constructs were all greater than 0.5. The discriminant validity criteria were also satisfied by comparing the square root of AVE and the inter-construct correlation values (Table 2).

Based on our univariable logistic regression, mothers' perception of susceptibility, severity, benefits, barriers and cues to action were significantly associated with mothers' intention to vaccinate their children. In addition, mothers' intention to vaccinate, was

Table 1 Mothers' characteristics in relation to intention to vaccinate their children (n = 595)

	Total, n (%)	Intention, n (%) 367 (61.68)	No intention, n (%) 228 (38.32)
Age			
20–30	48 (8.07)	21 (5.72)	27 (11.84)
31–40	330 (55.46)	202 (55.04)	128 (56.14)
>40	217 (36.47)	144 (39.24)	73 (32.02)
Race			
Caucasian/non-Hispanic White	429 (72.10)	261 (71.12)	168 (73.68)
Non-White	166 (27.90)	106 (28.88)	60 (26.32)
Marital status			
Single/separated/divorced/widowed	58 (9.75)	28 (7.63)	30 (13.16)
Married or in a cohabiting relationship	537 (90.25)	339 (92.37)	198 (86.84)
Residential area			
Large city	420 (70.59)	260 (70.84)	160 (70.18)
Small city/rural area	175 (29.41)	107 (29.16)	68 (29.82)
Educational level			
Some high school or high school diploma	34 (5.71)	19 (5.18)	15 (6.58)
Up to 2 years of college	96 (16.13)	45 (12.26)	51 (22.37)
At least 4 years of college	465 (78.15)	303 (82.56)	162 (71.05)
Child chronic health condition			
No	492 (82.69)	303 (82.56)	189 (82.89)
Yes	103 (17.31)	64 (17.44)	39 (17.11)
Job loss due to the COVID-19 pandemic			
No	488 (82.02)	303 (82.56)	185 (81.14)
Yes	107 (17.98)	64 (17.44)	43 (18.86)
Healthcare workers among the household			
No	378 (63.53)	224 (61.04)	154 (67.54)
Yes	217 (36.47)	143 (38.96)	74 (32.46)
COVID-19 infection in the household			
No	481 (80.84)	302 (82.29)	179 (78.51)
Yes	114 (19.16)	65 (17.71)	49 (21.49)
Number of children in the household			
1	250 (42.02)	165 (44.96)	85 (37.28)
2	261 (43.87)	166 (45.23)	95 (41.67)
3 or more	84 (14.12)	36 (9.81)	48 (21.05)

Table 2 HBM constructs in relation with intention (n = 595)

Scales[1]	Cronbach's alpha	Overall scale scores mean (SD) (n = 595)	Intention[2] mean (SD) 367 (61.68)	No intention[2] mean (SD) 228 (38.32)	Average variance extracted
Perceived susceptibility*	0.749	3.54 (0.95)	3.87 (0.74)	3.00 (1.00)	0.666
Perceived severity*	0.762	3.84 (0.88)	4.08 (0.70)	3.46 (0.99)	0.678
Perceived benefits*	0.921	4.08 (1.14)	4.64 (0.50)	3.14 (1.28)	0.927
Perceived barriers*	0.880	3.68 (1.11)	3.37 (1.12)	4.24 (0.82)	0.807
Cues to action*	0.816	3.74 (0.98)	4.15 (0.62)	3.06 (1.08)	0.648

[1]All scales were measured using a 5-point scale.

[2]Intention scores above 3 were considered intention for vaccination.

*P < 0.001; Mann–Whitney test was used to evaluate the statistical significance of variables.

significantly associated with their age, marital status, educational level and the number of children in their household (Table 3). Older age of mothers (P = 0.023 and P = 0.004) and being married or in a cohabiting relationship (P = 0.029) were significantly associated with mothers' intention to vaccinate their children against COVID-19 (Table 3). Evaluation of educational level indicated that having at least 4 years of college education was associated with mothers' intention to vaccinate (P < 0.001). Finally, having one or two children in comparison with having three or more children was associated with intention to vaccinate (P < 0.001) (Table 3).

All factors with P-values smaller than 0.25 (HBM constructs, age, marital status, education, healthcare worker among the household, COVID-19 infection in the household, and the number of children in the household) were included in the multivariable logistic regression model.[11] Based on our adjusted model, mothers' perceived susceptibility (P = 0.002), benefits (P < 0.001), barriers (P < 0.001) and cues to action (P < 0.001) were associated with intention to vaccinate (Table 3). In addition, the presence of a healthcare worker among the household was significantly associated with mothers' intention to vaccinate (P = 0.032).

To have a deeper understanding of perceived barriers, the mean scores of all barrier items were compared between the mothers with intention and mothers with no intention to vaccinate (Table 4). Mothers with no intention to vaccinate, had significantly higher

Table 3 Logistic regression of factors associated with mothers' intention to vaccinate children against COVID-19

Variables	OR (95% CI)	*P*-value	aOR (95% CI)	*P*-value
Health belief model constructs				
Perceived susceptibility	3.13 (2.59 to 3.93)	<0.001	1.75 (1.23 to 2.50)	0.002
Perceived severity	2.44 (1.95 to 3.04)	<0.001	0.74 (0.48 to 1.14)	0.170
Perceived benefits	6.15 (4.53 to 8.34)	<0.001	3.79 (2.47 to 5.80)	<0.001
Perceived barriers	0.41 (0.33 to 0.50)	<0.001	0.52 (0.39 to 0.69)	<0.001
Cues to action	4.73 (3.56 to 6.29)	<0.001	3.07 (2.08 to 4.55)	<0.001
Healthcare worker among the household				
Yes	1.33 (0.94 to 1.88)	0.109	1.79 (1.05 to 3.04)	0.032
COVID-19 infection in the household				
Yes	0.79 (0.52 to 1.19)	0.245	0.93 (0.50 to 1.72)	0.808
Age (ref. 20–30 years)				
31–40 years	2.03 (1.10 to 3.74)	0.023	0.99 (0.34 to 2.90)	0.981
41 years and beyond	2.54 (1.34 to 4.79)	0.004	1.27 (0.41 to 3.91)	0.682
Marital status (ref. single, widowed or divorced)				
Married or in a cohabiting relationship	1.83 (1.06 to 3.16)	0.029	0.92 (0.35 to 2.45)	0.871
Educational level (ref. 2 years of college education)				
Some high school or high school diploma	1.44 (0.65 to 3.15)	0.368	2.80 (0.80 to 9.80)	0.108
Four years of college	2.12 (1.36 to 3.30)	<0.001	0.85 (0.41 to 1.78)	0.674
Number of children (ref. three children or more)				
1	2.59 (1.56 to 4.29)	<0.001	1.44 (0.63 to 3.28)	0.383
2	2.33 (1.41 to 3.84)	<0.001	1.28 (0.57 to 2.86)	0.554
Child having chronic health conditions (ref. no chronic health condition)				
Yes	1.02 (0.66 to 1.59)	0.917		
Residential area (ref. small city/rural area)				
Large city	1.03 (0.72 to 1.48)	0.861		
Job loss during the COVID-19 pandemic (ref. No)				
Yes	0.91 (0.59 to 1.39)	0.661		

aOR, adjusted odds ratio; CI, confidence interval.

Table 4 Perceived barriers and cues to action in relation with intention ($n = 595$)

Items[1]	Overall scale scores mean (SD)	Intention[2] mean (SD) $n = 367$	No intention[2] mean (SD) $n = 228$	*P*-value
Perceived barriers				
Safety	3.75 (1.29)	3.35 (1.31)	4.39 (0.94)	<0.001
Efficacy	3.47 (1.23)	3.22 (1.23)	3.87 (1.12)	<0.001
Affordability	2.33 (1.24)	2.33 (1.31)	2.32 (1.12)	0.431
Side effects	3.91 (1.17)	3.55 (1.19)	4.49 (0.85)	<0.001
Scheduling difficulty	2.76 (1.28)	3.05 (1.34)	2.28 (1.02)	<0.001
Cues to action				
Adequate information provided	3.86 (1.18)	4.03 (1.01)	3.59 (1.38)	0.001
General public accepting the vaccine	3.50 (1.24)	3.93 (1.00)	2.80 (1.26)	<0.001
School district requirement	3.57 (1.32)	4.11 (1.04)	2.70 (1.26)	<0.001
Doctors' recommendation	4.00 (1.16)	4.54 (0.68)	3.14 (1.26)	<0.001

[1]All items were measured using a 5-point scale.
[2]Intention scores above 3 were considered intention for vaccination.

mean scores on safety, efficacy and side effects ($P < 0.001$). On the other hand, the mean score regarding scheduling difficulty was significantly lower among mothers with no intention to vaccinate their children ($P < 0.001$).

Further comparison of cues to action between the mothers with intention and mothers with no intention to vaccinate indicated lower mean scores on all items (Table 4). Adequate information being provided had the highest mean score among mothers with no intention to vaccinate ($P = 0.001$). The second strongest cue to action for hesitant mothers was doctors' recommendation followed by general public accepting the vaccine, and vaccines being required by school districts ($P < 0.001$).

Discussion

Overall, 38.32% of mothers had no intention to consider COVID-19 vaccine for their children which is a high number considering the disease and the risk. Our study indicated that mothers' perception of susceptibility, benefits, barriers and cues to action were associated with mothers' intention to vaccinate. Our data also revealed that vaccine safety, efficacy and side effects are the main concerns of hesitant mothers. We found that the strongest stimulation to combat mothers' hesitancy is adequate information about the vaccines being provided, followed by doctors' recommendations. Therefore, our findings support the implementation of strategies to increase

COVID-19 vaccine acceptance by addressing the HBM domains of perceived susceptibility, barriers and cues to action. In addition, we identified a positive association between the presence of a healthcare worker in the household and mothers' intention to vaccinate.

Our study suggests that hesitant mothers do not perceive COVID-19 infection as a serious threat for their children. The low perceived susceptibility seems extremely dangerous in a situation that Delta variant is rapidly spreading and the number of hospitalized patients is rising.[13] Parents need to consider that not only the Delta variant is more transmissible, but also it might be less treatable with the monoclonal antibody treatments used for the Alpha variant.[14]

Besides the lower perceived susceptibility, mothers with no intention, had higher concerns regarding the safety, efficacy and side effects of the COVID-19 vaccine. Another study conducted in Turkey found similar concerns among parents regarding COVID-19 vaccination.[15] They also indicated that the strongest cue to action for them was enough information about the vaccine being provided.[15] The FDA as the main authority responsible for providing reliable information regarding safety, efficacy and side effects of medications issued EUA for Pfizer and Moderna vaccines in December 2020 and the vaccination was initiated afterward.[16] However, after 7 months of COVID-19 vaccine utilization under the EUA, the safety and efficacy of any of the vaccines have not been approved by the FDA yet.

In addition to the mothers' concerns not fully addressed by FDA, the lack of FDA approval may be a major barrier for federal and local governments to implement mandatory policies that might increase COVID-19 vaccine uptake. It has been shown that even when employers tried several techniques to enhance voluntary immunization among their employees by bringing vaccines to their workplaces and meetings, the vaccination rate was still under 50%.[17] The only approach with near 100% compliance might be mandatory vaccination with a warning that if employees are willing to keep their jobs, they have to receive a vaccine.[17] However, it does not seem to be ethical or practical unless the COVID-19 vaccine is approved by the FDA.

Along with the prolonged process for FDA approval of the vaccine, disinformation about the rare but serious side effects of the vaccines may have increased hesitancy towards the safety of COVID-19 vaccination.[18] Based on the Vaccine Adverse Event Reporting System (VAERS), after administration of more than 342 million doses of COVID-19 vaccines in the USA, 6340 death (0.0019%) among people who received a COVID-19 vaccine have been reported.[19] Even though the rate of deaths possibly due to COVID-19 vaccination is extremely low, the rising amount of false propaganda on social media is generating serious confusion and insecurity among the people regarding the vaccine safety, efficacy and side effects.[20]

Our study also indicated that the presence of a healthcare worker among the household is associated with intention to vaccinate. Furthermore, our data indicated that doctors' recommendation was the second strongest stimulus for enhancing the vaccine uptake among the mothers who had no intention to vaccinate their children. These findings indicate how important might be the role of healthcare worker either as a family member or as a healthcare provider. In a study carried out in France on more than 2000 healthcare workers, 76.9% of them had acceptance for the COVID-19 vaccine which was higher than the acceptance rate of COVID-19 vaccine among the general population.[21]

Limitations of this study that should be considered include the higher average level of education and a slightly higher percentage of Caucasian/non-Hispanic White compared with the general US population which could potentially limit the generalizability of the study. Our sample might not be an excellent representative of all parents, since only mothers were included in this study. In addition, due to the voluntary recruitment in this study, our findings were not immune to non-respondent bias. Lastly, like any cross-sectional study design, interpretations should be with careful consideration and understanding that cross-sectional studies are purely descriptive and used to assess the burden of a particular problem in a defined population.

Conclusion

Implementation of strategies to improve parents' knowledge about the safety, efficacy and side effects of COVID-19 vaccine for children through paediatricians and other healthcare workers is highly acceptable and will improve the willingness for vaccination. Finally, enhancement of vaccine evaluation process by the FDA may provide more reliable information for parents and make mandatory policies more legitimate.

Supplementary Material

Supplementary data are available at *Journal of Pharmaceutical Health Services Research* online.

Author Contributions

Dr M.Z. conceptualized and designed the study, designed the data collection instruments, collected data, drafted the initial manuscript, and reviewed and revised the manuscript. J.L. participated in the conceptualization of the study, conducted pilot studies for survey validation, carried out the initial analyses, drafted parts of the initial manuscript, and reviewed and revised the manuscript. S.D.S. participated in the conceptualization of the study, conducted the literature review, conducted pilot studies for survey validation, collected data, and reviewed and revised the manuscript. Dr E.J.E. and Dr S.S.S. participated in the conceptualization of the study, coordinated, and supervised data collection, and critically reviewed the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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Conflict of Interest

All the authors declare no conflicts of interest.

Data availability

The data that support the findings of this study are available from the corresponding author, SSS, upon reasonable request.

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