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COVID-19 vaccination in Chinese children: a cross-sectional study on the cognition, psychological anxiety state and the willingness toward vaccination

Jin Yang^{a*}, Ting Zhang^{a,b*}, Weiran Qi^a, Xingxing Zhang^a, Mengmeng Jia^{a,b}, Zhiwei Leng^{a,b}, Qing Wang^a, Yuan Yang^a, Weizhong Yang^{a,b}, Libing Ma^{a,b,c}, Luzhao Feng^{a,b}, and Chen Wang^d

^aSchool of Population Medicine and Public Health, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China; ^bInstitute of Pharmaceutical and Medical Devices Supervision, National Medical Products Administration-Chinese Academy of Medical Sciences, Beijing, China; ^cDepartment of Respiratory and Critical Care Medicine, Affiliated Hospital of Guilin Medical University, Guilin, China; ^dChinese Academy of Medical Sciences & Peking Union Medical College, Beijing, China

ABSTRACT

It is important to understand the cognition, willingness, and psychological anxiety state of Chinese guardians toward COVID-19 vaccination for their children to predict the future vaccination rate and to help the design of policies that aim to expand the population with immunity against COVID-19. This study collected data with a professional vaccination registration platform for children named “Xiao Dou Miao” in February 2021. The psychological anxiety state of the guardians was self-evaluated using the psychological anxiety scale. Factors that might influence the willingness of guardians to vaccinate their children were identified using logistic regression analysis. This study included 12,872 questionnaires with 70.9% of guardians showing willingness to vaccinate their children. Guardians who were male, aged 40–49 and from rural area were more willing to vaccinate their children. Fathers, guardians with higher education and income, whose children have a history of adverse vaccine reactions and allergies were less willing to vaccinate their children ($p < .001$). More than 80% of the guardians expressed a high level of trust for vaccine information released by official and health-related agencies. Guardians who were not vaccinated were more anxious than those who were vaccinated ($\chi^2 = 27.99, p < .001$). To protect children from COVID-19, vaccine coverage in children should be expanded rapidly and public awareness on vaccine safety and effectiveness should be improved.

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Introduction

During the outbreak and the widespread epidemic of COVID-19, treatment for COVID-19 is still under development. Non-pharmaceutical interventions (NPIs) can reduce the frequency and size of the COVID-19 outbreak but have limited effect on containing the pandemic for longer time period. Therefore, vaccination is the most effective measure to limit or even stop the spread of COVID-19. Currently, a total of 102 vaccines in clinical development.¹ In China, 4 COVID-19 vaccines have been marketed in accordance with laws and regulations. The objective of this study was to investigate the guardians' cognition, willingness, and psychological anxiety status toward the COVID-19 vaccine for their children and thus provide data that may facilitate policymaking and contribute to the COVID-19 vaccination progress. This research provided reference for future vaccine coverage in children which will promote the development of herd immunity to end the pandemic.


Materials and methods

Study design

Data were collected from an online self-administered questionnaire distributed by “Xiao Dou Miao” (XDM), a mobile application for guardians to make inquiries and communicate on topics such as children vaccination and parenting. It covered 31 provinces of mainland China, autonomous regions, and municipalities in China with, 30 million registered users. Guardians of children who have access to the “XDM” APP conducted the survey. The questionnaire was made through the “Questionnaire Star” Website (<https://www.wjx.cn/>), a website that provides service on designing questionnaires for researchers. The questionnaire survey was conducted from February 7, 2020 to February 19, 2020. This survey included demographic, sociological information, vaccine cognition, vaccination willingness and psychological anxiety status. The self-rating psychological anxiety scale (Self-Rating Anxiety Scale, SAS) was used to evaluate the subjects'

CONTACT Libing Ma  malibing1984@163.com  School of Population Medicine and Public Health, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing 100730, China; Luzhao Feng  fengluzhao@cams.cn  Institute of Pharmaceutical and Medical Devices Supervision, National Medical Products Administration-Chinese Academy of Medical Sciences, Beijing 100730, China

*These authors contributed equally to this work.

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psychological anxiety state. A total of 20 items were scored with 4-level scoring rules (“1” means no or negligible time; “2” means sometimes; “3” means most of the time; “4” means most or all of the time). Positive statements were scored in reverse according to 4–1. The scores of 20 items were summed to get a rough score. After multiplying the rough score by 1.25, the integer part was taken as the standard score. The positive threshold of anxiety was 50.

Statistical analysis

Continuous variables with a normal distribution were expressed as mean and SD values, while other continuous variables were expressed as median (25th–75th percentile) values. Categorical variables were expressed as percentages. Binary Logistic regression (backward method) was used to investigate influencing factors. Only statistically significant variables in the univariate logistic regression models were further analyzed in multivariate logistic regression models. All statistical tests were two-sided, with $P < .05$ considered as statistically significant. All statistical analyses were performed using R software (version 4.0.2).

This study was approved by the Medical Ethics Committee of the Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China (IPB-2020-15).

Results

Study sample characteristics

We received 12,892 questionnaires in total for this study. Minors and invalid questionnaires were excluded. After exclusion, we analyzed 12,872 questionnaires. Among the participants, 9,408 (73.09%) were mothers, 3,064 (23.80%) were fathers and 400 were other guardians such as grandparents, aunts, uncles, and so on (3.11%). The ratio of female to male was 2.98:1. The major age group in this study was 30–39 years old which covered 7,241 (56.25%) guardians. The ratio of participants from urban to those from rural areas was 1.86:1. Education, family income and occupations of the surveyed guardians were summarized in Table 1. Moreover, 11,190 (86.93%) children whose guardians were surveyed had no adverse reactions in the past vaccination, 7,740 (60.13%) had no history of allergies, and 12,635 (98.16%) had no underlying diseases. In addition, 70.87% of guardians showed willingness to vaccinate their children (Table 1).

Cognition in SARS-CoV-2 and COVID-19 vaccine

Among the guardians, 7,439 (57.79%) respondents considered that infection with SARS-CoV-2 can cause great or very great harm to their health; 7,556 (58.70%) respondents said they were concerned or very concerned about their exposure to SARS-CoV-2; 10,313 (80.12%) said they were concerned or very concerned about the sequelae of SARS-CoV-2 infection. For questions on children, 7,338 (57.01%) guardians thought that infection with SARS-CoV-2 can induce great or very great harm to their children’s health; 10,712 (83.22%) guardians

concerned or very concerned about their children’s exposure to SARS-CoV-2; 11,607 (90.17%) concerned or very concerned about the sequelae of SARS-CoV-2 infection of their children.

From this survey, 10,857 (84.35%) guardians mostly or completely trusted information on the COVID-19 vaccine released by health professional institutions and 11,554 (89.76%) mostly or completely supported the national vaccination strategy. Further, 8,512 respondents (66.12%) mostly/completely agreed that COVID-19 vaccine can prevent SARS-CoV-2 infection. Moreover, 3,839 (29.83%) partially/completely disagreed that they will have adverse reactions due to vaccination. On questions about children, 7,910 respondents (61.45%) mostly/completely agreed that COVID-19 vaccine can prevent their child from SARS-CoV-2 infection and 2,824 (21.94%) partially/completely disagreed that their children would have adverse reactions after vaccination (Figure 1, Table S1-2).

Guardians willingness to vaccinate their children

If the children are eligible for vaccination, 9,122 (70.87%) guardians were willing to sign up the children for vaccination (Table 1). However, 566 (4.40%) guardians were not willing and 3,184 (24.74%) were uncertain. For most guardians, the mean reason to vaccinate their children was that the vaccine can effectively reduce the risk of infection for children and is safe and reliable, whereas the mean reason for not vaccinating their children was the concern about vaccine safety (Figure 2).

We further investigated whether guardians were willing to vaccinate their children. The logical regression analysis showed that male (vs. female, OR = 2.04, 95%CI: 1.22–3.41), aged 40–49 (vs. 18–29, OR = 1.25, 95%CI: 1.08–1.45), guardians from rural area (vs. urban, OR = 1.13, 95%CI: 1.03–1.24) were more willing to vaccinate their children. Factors that associated with the lack of willingness to vaccinate the children of respondents were father (vs. mother, OR = 0.53, 95%CI: 0.32–0.90), higher vocational education (vs. secondary education/secondary vocational education and below, OR = 0.78, 95%CI: 0.71–0.86), undergraduates (vs. secondary education/secondary vocational education and below, OR = 0.72, 95%CI: 0.64–0.80), post-graduates and above (vs. secondary education/secondary vocational education and below, OR = 0.58, 95%CI: 0.47–0.72), the range of family income per capita (CNY) between 100,000–200,000 (vs. $\leq 100,000$, OR = 0.88, 95%CI: 0.80–0.97), a family income of 300,000 and above (vs. $\leq 100,000$, OR = 0.73, 95%CI: 0.60–0.88), children with an history of adverse reactions after receiving vaccines in the past (vs. no adverse reactions, OR = 0.60, 95%CI: 0.54–0.67), children with any allergic history (vs. no adverse reactions, OR = 0.79, 95%CI: 0.71–0.87) and children with unknown allergic history (vs. no adverse reactions, OR = 0.68, 95%CI: 0.62–0.75) (Table 2).

Psychological anxiety

We divide the guardians into three groups: “Actively make appointments for vaccinations” included respondents who

Table 1. The basic characteristics of guardians and willingness to vaccinate their children in the survey.

Variables	Number (%)	Number of guardians willing to vaccinate their children (%)
Total	12872 (100)	9122 (70.87)
Guardians		
Mother	9408 (73.09)	6590 (70.05)
Father	3064 (23.80)	2223 (72.55)
Others	400 (3.11)	309 (77.25)
Sex		
Female	9634 (74.84)	6753 (70.10)
Male	3238 (25.16)	2369 (73.16)
Age group (years)		
18–29	3933 (30.55)	2798 (71.14)
30–39	7241 (56.25)	5040 (69.60)
40–49	1371 (10.65)	1035 (75.49)
≥50	327 (2.54)	249 (76.15)
Region		
Urban	8370 (65.02)	5764 (68.86)
Rural	4502 (34.98)	3358 (74.59)
Education		
Secondary education/ secondary vocational education and below	5636 (43.78)	4261 (75.60)
Higher vocational education	3269 (25.40)	2262 (69.20)
Undergraduates	3503 (27.21)	2323 (66.31)
Postgraduates and above	464 (3.60)	276 (59.48)
Family income per capita (CNY)		
≤100,000	8064 (62.65)	5912 (73.31)
100,000–200,000	3536 (27.47)	2393 (67.68)
200,000–300,000	712 (5.53)	473 (66.43)
≥300,000	560 (4.35)	344 (61.43)
Occupations		
Housewives	5125 (39.82)	3197 (62.38)
Others	4665 (36.24)	3751 (80.41)
Service workers	762 (5.92)	553 (72.57)
Healthcare-related workers	719 (5.59)	491 (68.29)
Education-related workers	656 (5.10)	474 (72.26)
Public officer	482 (3.74)	310 (64.32)
Laborers	463 (3.60)	346 (74.73)
Does your child ever had any adverse reactions after receiving vaccines in the past?		
NO	11190 (86.93)	8128 (72.64)
Yes	1682 (13.07)	994 (59.10)
Does your child ever had any allergic history?		
NO	7740 (60.13)	5715 (73.84)
Yes	2412 (18.74)	1619 (67.12)
Unknown	2720 (21.13)	1788 (65.74)
Does your child have underlying diseases?		
NO	12635 (98.16)	8964 (70.95)
Yes	237 (1.84)	158 (66.67)

The baseline table includes the guardian's demographic characteristics and the child's history of other vaccine adverse reactions, allergies, and underlying diseases. CDC: Chinese Center for Disease Control and Prevention.

applied for vaccination with or without scheduled appointment; “No vaccination appointment” included those did not apply for vaccination; “Already vaccinated” included those who had been vaccinated. At the time of this survey, a total of 594 guardians actively made an appointment for the COVID-19 vaccine, of which 21 was anxious and had an anxiety rate of 3.54%. In addition, 11,039 people did not make an appointment and had an anxiety rate of 3.93%. Among 1,239 respondents who received the COVID-19 vaccine, 12 people were anxious, and the anxiety rate was 0.97%. The mean SAS scores of the active appointment group, no appointment group and the vaccinated group were 42.89, 42.68, and 42.85, respectively. Guardians who had not been vaccinated were more anxious than those who had been vaccinated ($\chi^2 = 27.99$, $p < .001$). The active appointment group were more anxious than those who had been vaccinated ($\chi^2 = 14.96$, $p < .001$) The no appointment group were more

anxious than those who had been vaccinated ($\chi^2 = 27.94$, $p < .001$). There was no significant difference between the active appointment group and the no appointment group, $\chi^2 = 0.24$, $p = .71$ (Table 3).

Discussion

The COVID-19 vaccine is the most effective and economical measure to prevent and control the pandemic.² However, the vaccination rate will largely depend on the public attitude and willingness toward the vaccination^{3,4}. Moreover, the effectiveness of existing vaccines to prevent the spread of new coronaviruses and diseases may be compromised due to low level of public acceptance rate⁵. The strategy of the government and health-related institutions to promote the willingness toward vaccination has a significant impact on the vaccination rate^{6,7}. Some countries and regions had carried out related studies on

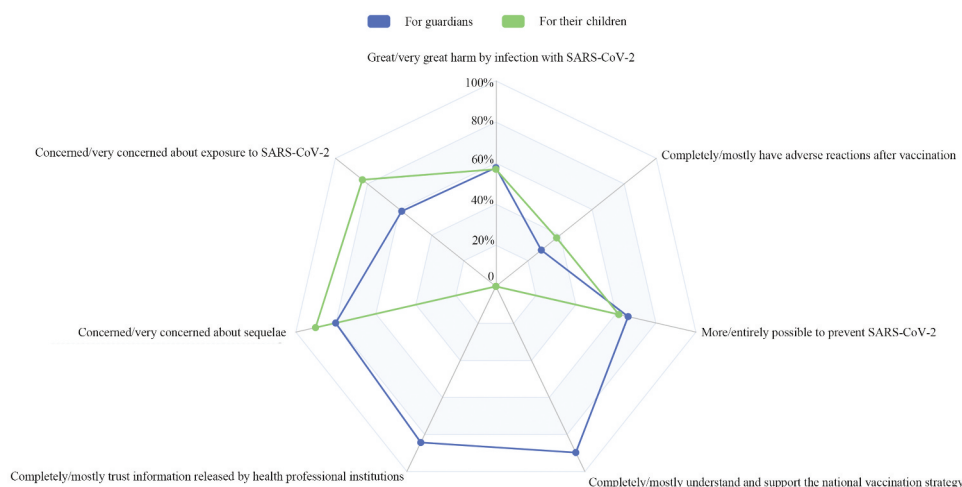


Figure 1. Investigation on the cognition of SARS-CoV-2 and COVID-19 about guardians. note: Blue line represented the guardian’s own cognition on SARS-CoV-2 and COVID-19. Green line represented the guardian’s own cognition on SARS-CoV-2 and COVID-19 for children. The percentage represented the proportion of people choose this option among total respondents.

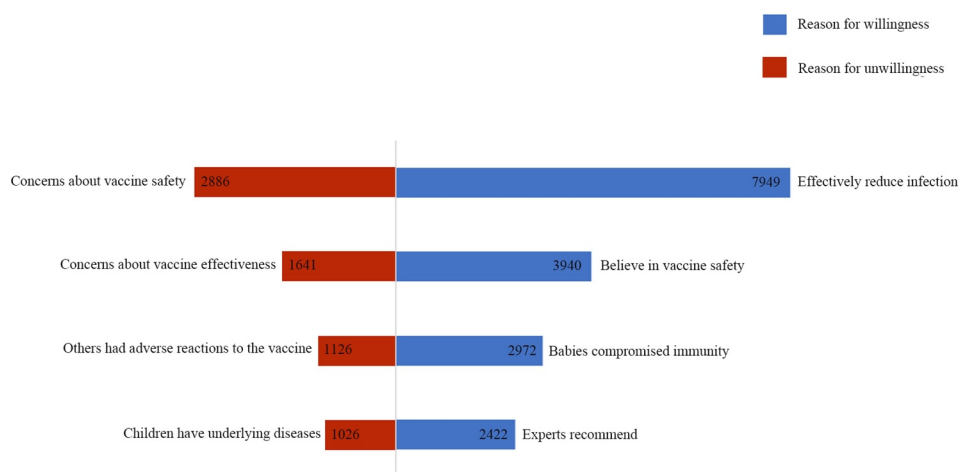


Figure 2. Reasons why guardians were willing or unwilling to vaccinate their children. note: This question was a question with multiple choice. Blue represented the reason why guardians were willing to vaccinate their children. Red represented the reason why guardians were unwilling to vaccinate their children. The number of people who chose this option was annotated.

the public acceptance of the COVID –19 vaccine: the acceptance rate was 91.3% in China, 85% in Brazil, 80% in South Africa, 80% in South Korea, 60% in France, 55% in Russia, and 50% to 74% in the United States,^{8–12}. Some countries also showed low willingness to vaccinate: 27.7% in Congo and 29.4% in Arab countries^{13,14}. However, there were few investigations on children’s guardians and their willingness to have their children vaccinated in China. Although the vaccine has not been approved to be used on children, it is important to investigate whether their guardians are willing to give vaccination to the children.

Our results showed that the vaccination willingness was higher in guardians who considered that the vaccine was safe and effective for their children that met the criteria for vaccination (70.87%). In contrast, a British study showed that 48.2% of parents were willing to vaccinate their children with COVID-19 vaccine, and 40.9% of parents were not sure.¹⁵ We found that, compared with the guardians themselves (58.70%), more guardians (83.22%) were worried that

their children would be infected with COVID-19 and 90.17% of them worried that the children might have sequelae if they are infected with COVID-19. Indeed, a systematic review reported that children less than five years old were the main group among youth that were affected by COVID-19 till date.¹⁶ Therefore, it is possible that Chinese guardians may have higher anxiety level toward the health status of their children than that of British guardians and thus are more willing to take precautions such as vaccines. However, we found that with higher education and higher income, guardians of children with a history of adverse vaccine reactions and allergies were reluctant to vaccinate their children. Similarly, Ran D Goldman et al. found that guardians with higher education history were less likely to enroll their child in the COVID-19 vaccine trail (OR = 0.68, 0.47–0.97) whereas those with lower education were more likely to do (OR = 1.79, 1.18–2.74).¹⁷ With deeper understanding of knowledge on the effectiveness and side effects of the COVID-19 vaccine, guardians were more cautious about

Table 2. Influencing factors on the willingness of guardians to vaccinate their children.

Variables	Univariate analysis		Multivariate analysis	
	OR	95%CI	OR	95%CI
Guardians				
Mother	1.16	1.07–1.24	Ref	
Father			0.53	0.32–0.90
Others			1.11	0.77–1.60
Sex				
Female	1.16	1.06–1.27	Ref	
Male			2.04	1.22–3.41
Age group (years)				
18–29	1.07	1.01–1.13	Ref	
30–39			0.99	0.91–1.09
40–49			1.25	1.08–1.45
≥50			0.87	0.60–1.28
Region				
Urban	1.33	1.22	Ref	
Rural			1.13	1.03–1.24
Education				
Secondary education/ secondary vocational education and below	0.79	0.76–0.83	Ref	
Higher vocational education			0.78	0.71–0.86
Undergraduates			0.72	0.64–0.80
Postgraduates and above			0.58	0.47–0.72
Family income per capita (CNY)				
≤100,000	0.82	0.79–0.86	Ref	
100,000–200,000			0.88	0.80–0.97
200,000–300,000			0.87	0.73–1.03
≥300,000			0.73	0.60–0.88
Occupations				
Housewives				
Others				
Service workers				
Healthcare-related workers	1.01	0.99–1.04	/	/
Education-related workers				
Public officer				
Laborers				
Does your child ever had any adverse reactions after receiving vaccines in the past?				
NO	0.54	0.49–0.61	Ref	
Yes			0.60	0.54–0.67
Does your child ever had any allergic history?				
NO	0.81	0.78–0.85	Ref	
Yes			0.79	0.71–0.87
Unknown			0.68	0.62–0.75
Does your child have underlying diseases?				
NO	0.82	0.62–1.08	/	/
Yes				

OR: odds ratio; CI: confidence interval.

Table 3. Self-rating anxiety scale of four different groups.

Variables	Active appointment	No appointment	Already vaccinated
Total	594	11039	1239
Number of anxious	21	434	12
Rate of anxious	3.54%	3.93%	0.97%
Score: Mean ± SD	42.89 ± 4.37	42.68 ± 4.53	42.85 ± 3.07
χ^2		27.99	
<i>p</i> -value		<0.001	

There was a significant difference between the vaccinated group and the active appointment group, $\chi^2 = 14.96$, $P < 0.001$; there was a significant difference between the vaccinated group and the no appointment group, the $\chi^2 = 27.94$, $P < 0.001$; There was no significant difference between the active appointment group and the no appointment group, $\chi^2 = 0.24$, $P = 0.71$.

vaccination especially for children. The United Nations Children's Fund (UNICEF) has called for the global acceleration of vaccine development to guarantee every child's right to COVID-19 diagnosis, treatment, and vaccination.¹⁸ In this study, we found that 68.29% of health care workers

(HCWs) were willing to vaccinate their children. The main reasons that hindered the willingness to vaccinate children for the rest of HCWs were their concerns on the safety and effectiveness of the vaccine. Our research showed that most guardians were more worried about that SARS-Cov-2 might harm their children health and lead to sequelae than they are about themselves. We also analyzed the psychological anxiety level of the guardians with or without vaccination. People who had not been vaccinated were more likely to have psychological anxiety than those who had been vaccinated. The scores of all respondents did not exceed the threshold of anxiety. However, we should still pay attention to the psychological anxiety level in the general population. The overall low anxiety level of the respondents might because that most people had confidence on the effectiveness of vaccines and that it can prevent the SARS-Cov-2 and produce few adverse events.

In addition to a series of practical measures to control the epidemic,¹⁹ the Chinese government has strengthened

the overall management of the health administration department and public health institutions at all levels to complete the implementation of vaccine-related arrangements. The prompt public health emergency response gave the government high credibility and the early advertisement laid the foundation to achieve a high vaccination rate in the future and the public's awareness of the importance in developing a barrier against infection with immune system. Indeed, more than 80% of the public had high level of trust for the information about vaccines released by official and health-related agencies. Therefore, we should continue to use the resource from the government, medical institutions, and educational institutions to advocate vaccination, wearing masks, and social distancing. Doubts, worries, and hesitations about the effectiveness and safety of vaccines remain the main reasons that hinder vaccine coverage.²⁰ More efforts should be made to disseminate information about vaccines to ensure acceptance and coverage.²¹

This study still has some limitations. First of all, this survey is conducted in the form of an online questionnaire which lack random sampling process. Therefore, this study was not representative for the whole population in China. Secondly, the subjects of study were mainly the guardians of children aged 0–6 years old, and the results should not be extrapolated to the whole population. Finally, there were information bias in the self-administered questionnaire. However, with the continuous challenge of the global epidemic, it is necessary to investigate the awareness, willingness, and psychology anxiety state of vaccination among different populations.

5. Conclusion

This is the first large-scale population study aimed to reveal the cognition and psychological anxiety state of Chinese guardians on COVID-19 vaccine and investigate the willingness to vaccinate their children. We found that 70.87% of guardians showed willingness to vaccinate their children. Father, guardians with higher education and income, whose children have a history of adverse vaccine reactions and allergies were less willing to vaccinate their children. For most guardians, the mean reason to not vaccinate their children was concern about vaccine safety. To expand vaccination coverage in whole population, it is important to investigate whether their guardians are willing to give vaccination to the children. Health education and communication from authoritative sources is an important way to alleviate public concerns about vaccine safety.

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ORCID

Libing Ma  <http://orcid.org/0000-0002-7234-2312>

References

1. World Health Organization. Coronavirus disease (COVID-19): COVID-19 vaccines; 2021 [accessed 2021 Jun 06]. <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/covid-19-vaccines>.
2. Lurie N, Saville M, Hatchett R, Halton J. Developing Covid-19 vaccines at pandemic speed. *N Engl J Med*. 2020;382(21):1969–73. doi:10.1056/NEJMp2005630.
3. Wang JH, Jing R, Lai XZ, Zhang HJ, Lyu Y, Knoll MD, Fang H. . Acceptance of COVID-19 vaccination during the COVID-19 pandemic in China. *Vaccines (Basel)*. 2020;8:3. doi:10.3390/vaccines8030482.
4. Lazarus JV, Ratzan SC, Palayew A, Gostin LO, Larson HJ, Rabin K, Kimball S, El-Mohandes A. A global survey of potential acceptance of a COVID-19 vaccine. *Nat Med*. 2021;27(2):225–28. doi:10.1038/s41591-020-1124-9.
5. Murray CJL, Piot P. The potential future of the COVID-19 pandemic: will SARS-CoV-2 become a recurrent seasonal infection? *JAMA*. 2021;325(13):1249. doi:10.1001/jama.2021.2828.
6. Lin C, Tu P, Beitsch LM. Confidence and receptivity for COVID-19 vaccines: a rapid systematic review. *Vaccines (Basel)*. 2020;9:1. doi:10.3390/vaccines9010016.
7. Lin Y, Hu Z, Zhao Q, Alias H, Danaee M, Wong LP. Understanding COVID-19 vaccine demand and hesitancy: a nationwide online survey in China. *PLoS Negl Trop Dis*. 2020;14(12):e0008961. doi:10.1371/journal.pntd.0008961.
8. Neumann-Böhme S, Varghese NE, Sabat S, Barros PP, Brouwer W, Exel J, Schreyögg J, Stargardt T. Once we have it, will we use it? A European survey on willingness to be vaccinated against COVID-19. *Eur J Health Econ*. 2020;21(7):977–82. doi:10.1007/s10198-020-01208-6.
9. Detoc M, Bruel S, Frappe P, Tardy B, Botelho-Nevers E, Gagneux-Brunon A. Intention to participate in a COVID-19 vaccine clinical trial and to get vaccinated against COVID-19 in France during the pandemic. *Vaccine*. 2020;38(45):7002–06. doi:10.1016/j.vaccine.2020.09.041.
10. Pogue K, Jensen JL, Stancil CK, Ferguson DG, Hughes SJ, Mello EJ, Burgess R, Berges BK, Quaye A, Poole BD, et al. Influences on attitudes regarding potential COVID-19 vaccination in the United States. *Vaccines (Basel)*. 2020;8:4. doi:10.3390/vaccines8040582.
11. Szilagyi PG, Thomas K, Shah MD, Vizueta N, Cui Y, Vangala S, Kapteyn A. National trends in the US public's likelihood of getting a COVID-19 vaccine-April 1 to December 8, 2020. *JAMA*. 2020. doi:10.1001/jama.2020.26419.
12. Daly M, Robinson E. Willingness to vaccinate against COVID-19 in the US: longitudinal evidence from a nationally representative sample of adults from April-October 2020. *medRxiv*. 2020. doi:10.1101/2020.11.27.20239970.
13. Sallam M, Dababseh D, Eid H, Al-Mahzoum K, Al-Haidar A, Taim D, Yaseen A, Ababneh NA, Bakri FG, Mahafzah A. High rates of COVID-19 vaccine hesitancy and its association with conspiracy beliefs: a study in Jordan and Kuwait among other Arab countries. *Vaccines (Basel)*. 2021;9:1. doi:10.3390/vaccines9010042.
14. Kabamba Nzaji M, Kabamba Ngombe L, Ngoie Mwamba G, Banza Ndala DB, Mbidi Miema J, Luhata Lungoyo C, Lora Mwimba B, Cikomola Mwana Bene A, Mukamba Musenga E. Acceptability of vaccination against COVID-19 among healthcare workers in the democratic republic of the Congo. *Pragmat Obs Res*. 2020;11:103–09. doi:10.2147/POR.S271096.

15. Bell S, Clarke R, Mounier-Jack S, Walker JL, Paterson P. Parents' and guardians' views on the acceptability of a future COVID-19 vaccine: a multi-methods study in England. *Vaccine*. 2020;38(49):7789–98. doi:10.1016/j.vaccine.2020.10.027.
16. Bhuiyan MU, Stiboy E, Hassan MZ, Chan M, Islam MS, Haider N, Jaffe A, Homaira N. Epidemiology of COVID-19 infection in young children under five years: a systematic review and meta-analysis. *Vaccine*. 2021;39(4):667–77. doi:10.1016/j.vaccine.2020.11.078.
17. Goldman RD, Staubli G, Cotanda CP, Brown JC, Hoeffe J, Seiler M, Gelernter R, Hall JE, Griffiths MA, Davis AL, et al. Factors associated with parents' willingness to enroll their children in trials for COVID-19 vaccination. *Hum Vaccin Immunother*. 2020;1–5. doi:10.1080/21645515.2020.1834325.
18. UNICEF:six-point-plan-protect-children; 2020 [accessed 2021 Mar 20]. <https://www.unicef.org/coronavirus/six-point-plan-protect-children>.
19. Leung K, Wu JT, Liu D, Leung GM. First-wave COVID-19 transmissibility and severity in China outside Hubei after control measures, and second-wave scenario planning: a modelling impact assessment. *Lancet*. 2020;395(10233):1382–93. doi:10.1016/S0140-6736(20)30746-7.
20. Gerussi V, Peghin M, Palese A, Bressan V, Visintini E, Bontempo G, Graziano E, De Martino M, Isola M, Tascini C, et al. Vaccine hesitancy among Italian patients recovered from COVID-19 infection towards influenza and Sars-Cov-2 vaccination. *Vaccines (Basel)*. 2021;9:2. doi:10.3390/vaccines9020172.
21. Chen M, Li Y, Chen J, Wen Z, Feng F, Zou H, Fu C, Chen L, Shu Y, Sun C, et al. An online survey of the attitude and willingness of Chinese adults to receive COVID-19 vaccination. *Hum Vaccin Immunother*. 2021;17(7):2279–88. doi:10.1080/21645515.2020.1853449.