Appendix

Appendix A Questionnaire – Main body
Questionnaire for caregivers

Informed Consent	
1	**Are you willing to take part in this survey?** (1)Yes; (2) No
Characteristics of the respondents	
2	**Where do you fill in the questionnaire?** _____ Province _____city/county
3	**Your gender:** (1) Male; (2) Female
4	**Your age:** _____ years old
5	**Your educational level:** (1) Primary school or below; (2) Junior middle school; (3) High school or vocational school; (4) Junior college; (5) Bachelor's degree; (6) Postgraduate degree or higher
6	**Your religion:** (1) None; (2) Buddhism; (3) Christianity; (4) Others
7	**Your relationship with the child:** (1) Mother; (2) Father; (3) Grandmother; (4) Grandfather; (5) Others
8	**Your child's gender:** (1) Male; (2) Female
9	**Child's birth date**: _____ year _____month
10	**Is the child the only child in your family?** (1)Yes; (2) No
11	**Your present occupation is:** (1) Civil servant; (2) Enterprise personnel; (3) Freelancer; (4) Self-employed; (5) Peasant; (6) Others_____
12	**Do you have Hukou in your residence?** (1)Yes; (2) No
13	**The total income of your family in the past year: _____** (1) Less than 10,000 yuan; (2) 10,000-20,000 yuan; (3) 20,000-50,000 yuan; (4) 50,000-100,000 yuan; (5) 100,000-200,000 yuan; (6) More than 200,000 yuan
Vaccine confidence	
These items mainly investigate your views on the importance, safety and efficacy of vaccines. Please indicate to what extent you agree/disagree with the following statements.	

14	Statements*	Strongly disagree	Disagree	Neutral/don't know	Agree	Strongly agree
(1)	Vaccines are important for my children to have					
(2)	Overall, I think vaccines are safe					
(3)	Overall, I think vaccines are effective					

COVID-19 vaccination	
15	**Have you taken the COVID-19 vaccine yourself?** (1) Yes, I have taken 2 doses of COVID-19 vaccines; (2) Yes, I have taken 1 dose of COVID-19 vaccines; (3) No, I haven't.
16	**What is the likelihood for children to catch COVID-19?** (1) Extremely low; (2) Low; (3) Neutral/don't know; (4) High; (5) Extremely high
17	**What is the likelihood for children to get severe symptoms (such as Respiratory failure) if catching COVID-19?** (1) Extremely low; (2) Low; (3) Neutral/don't know; (4) High; (5) Extremely high
18	**Do you know the minimum coverage rate of COVID-19 vaccination to control pandemic and reach herd immunity in China?** (1) <50% (2) 50% ~ 70%; (3) 70% ~ 80%; (4) >80%; (5) Don't know

*The answers of the three statements were assigned a score of 1 to 5 from strongly disagree to strongly agree, respectively. The score of vaccine confidence was calculated as means of the scores of the three statements.

Questionnaire for health care workers

Informed Consent	
1	**Are you willing to take part in this survey?** (1)Yes; (2) No
Characteristics of the respondents	
2	**Which city do you work in?** (1) Shenzhen City; (2) Dongzhi County; (3) Hefei City; (4) Jingyang County; (5) Qindu District, Xianyang City
3	**Your gender:** (1) Male; (2) Female
4	**Your age:** _____ years old
5	**Your educational level:** (1) High school or below; (2) Junior college; (3) Bachelor's degree; (4) Postgraduate degree or higher
6	**Your religion:** (2) None; (2) Buddhism; (3) Christianity; (4) Others
7	**Type of facility that you work in:** (1) Community health center; (2) Hospital
8	**Are you engaged in vaccination?** (1) Yes (general vaccination); (2) Yes (only participate in the COVID-19 vaccination); (3) No (Not engaged in vaccination)
9	**How many years have you been in your current occupation?** (1) Less than 1 year; (2) 1-3 years; (3) 3-5 years; (4) 5-10 years; (5) More than 10 years
10	**Your professional title:** (1) Junior; (2) Intermediate; (3) Senior

Vaccine confidence

These items mainly investigate your views on the importance, safety and efficacy of vaccines. Please indicate to what extent you agree/disagree with the following statements.

11	**Statements***	**Strongly disagree**	**Disagree**	**Neutral/don't know**	**Agree**	**Strongly agree**
(1)	Vaccines are important for my children to have					
(2)	Overall, I think vaccines are safe					

(3)	Overall, I think vaccines are effective					

COVID-19 vaccination	
12	**Have you taken the COVID-19 vaccine yourself?** (1) Yes, I have taken 2 doses of COVID-19 vaccines; (2) Yes, I have taken 1 dose of COVID-19 vaccines; (3) No, I haven't.
13	**What is the likelihood for children to catch COVID-19?** (1) Extremely low; (2) Low; (3) Neutral/don't know; (4) High; (5) Extremely high
14	**What is the likelihood for children to get severe symptoms (such as Respiratory failure) if catching COVID-19?** (1) Extremely low; (2) Low; (3) Neutral/don't know; (4) High; (5) Extremely high
15	**Do you know the minimum coverage rate of COVID-19 vaccination to control pandemic and reach herd immunity in China?** (1) <50% (2) 50% ~ 70%; (3) 70% ~ 80%; (4) >80%; (5) Don't know

*The answers of the three statements were assigned a score of 1 to 5 from strongly disagree to strongly agree, respectively. The score of vaccine confidence was calculated as means of the scores of the three statements.

Appendix B Questionnaire – Survey experiment

Please read the following information carefully, and then answer the questions below: **Herd immunity** refers to the indirect protection from infection conferred to susceptible individuals when a sufficiently large proportion of immune individuals exist in a population. This population-level effect is often considered in the context of vaccination programs, which aim to establish herd immunity so that those who cannot be vaccinated, including the very young and immunocompromised, are still protected against disease. In China, it would need more than **80 percent** of the population to be vaccinated before establishing herd immunity. (This information is set to be shown randomly with a probability of 50%)			
1	**Do you plan to take COVID-19 vaccines for your child when COVID-19 vaccines are approved for use in children ?** (1) Definitely yes; (2) Probably yes; (3) Not sure; (4) Probably not; (5) Definitely not		
2	**Are the statements below the reasons that you do not willing to take COVID-19 vaccines for your child**		
(1)	Children were too young to take COVID-19 vaccines.	Yes	No
(2)	COVID-19 vaccines are not very effective in children.	Yes	No
(3)	Concerns about the adverse reactions of COVID-19 vaccines on children.	Yes	No
(4)	The lack of evidence on safety and efficacy of COVID-19 vaccines on children.	Yes	No
(5)	Children do not need to be vaccinated against COVID-19 now that the epidemic is under control in China.	Yes	No
(6)	Children are less likely to be infected with COVID-19.	Yes	No
(7)	There are some negative information and reports about COVID-19 vaccines.	Yes	No
(8)	The child is not healthy enough to be vaccinated, such as allergy, illness, etc.	Yes	No

3. There are 8 different pairs of hypothetical COVID-19 vaccines below, please choose the vaccine you prefer to take for your child in each pair. You can also choose neither of the vaccines in each pair.

Vaccine efficacy refers to the extent to which vaccination reduces the infection risk compared to non-vaccination, with higher values indicating better vaccine efficacy.

Risk of adverse reactions refers to the likelihood of fever, localized redness, swelling and pain, etc occurring after vaccination (tissue and organ damage may occur in very few cases), reflecting vaccine safety.

Number of doses administered refers to the total number of doses required for a certain vaccine.

Choice task 1

	COVID-19 vaccine A	**COVID-19 vaccine B**
Vaccine efficacy	50%	90%
Risk of adverse reactions	10 cases / per ten thousand people	1 cases / per ten thousand people
Number of doses	1	2

Which vaccine above would you like to take for your child:

(1)Vaccine A; (2) Vaccine B; (3) Neither

Choice task 2

	COVID-19 vaccine A	**COVID-19 vaccine B**
Vaccine efficacy	90%	70%
Risk of adverse reactions	1 cases / per ten thousand people	10 cases / per ten thousand people
Number of doses	1	2

Which vaccine above would you like to take for your child:

(1)Vaccine A; (2) Vaccine B; (3) Neither

Choice task 3

	COVID-19 vaccine A	**COVID-19 vaccine B**
Vaccine efficacy	70%	50%
Risk of adverse reactions	10 cases / per ten thousand people	1 cases / per ten thousand people
Number of doses	2	1

Which vaccine above would you like to take for your child:

(1)Vaccine A; (2) Vaccine B; (3) Neither

Choice task 4

	COVID-19 vaccine A	**COVID-19 vaccine B**
Vaccine efficacy	70%	50%
Risk of adverse reactions	10 cases / per ten thousand people	1 cases / per ten thousand people
Number of doses	1	2

Which vaccine above would you like to take for your child:

(1)Vaccine A; (2) Vaccine B; (3) Neither

Choice task 5

	COVID-19 vaccine A	COVID-19 vaccine B
Vaccine efficacy	50%	70%
Risk of adverse reactions	10 cases / per ten thousand people	1 cases / per ten thousand people
Number of doses	2	1

Which vaccine above would you like to take for your child:

(1)Vaccine A; (2) Vaccine B; (3) Neither

Choice task 6

	COVID-19 vaccine A	COVID-19 vaccine B
Vaccine efficacy	50%	90%
Risk of adverse reactions	1 cases / per ten thousand people	10 cases / per ten thousand people
Number of doses	2	1

Which vaccine above would you like to take for your child:

(1)Vaccine A; (2) Vaccine B; (3) Neither

Choice task 7

	COVID-19 vaccine A	COVID-19 vaccine B
Vaccine efficacy	90%	70%
Risk of adverse reactions	10 cases / per ten thousand people	1 cases / per ten thousand people
Number of doses	2	1

Which vaccine above would you like to take for your child:

(1) Vaccine A; (2) Vaccine B; (3) Neither

Choice task 8

	COVID-19 vaccine A	COVID-19 vaccine B
Vaccine efficacy	50%	70%
Risk of adverse reactions	10 cases / per ten thousand people	1 cases / per ten thousand people
Number of doses	1	2

Which vaccine above would you like to take for your child:

(1) Vaccine A; (2) Vaccine B; (3) Neither

Appendix C Discrete choice experiment

Selection of COVID-19 vaccine attributes and levels

COVID-19 vaccine attributes and corresponding levels were selected using a sequential process. First, attributes and levels that could apply to COVID-19 vaccines were selected based on literature review of discrete choice experiments (DCE) on vaccination and real data on COVID-19 vaccines. Then, a list of three vaccine attributes (efficacy, safety, and manufacturer) were tested in brain-storming interviews with an expert panel. Based on interviews, we replaced one vaccine attribute, manufacturer of the vaccine (manufactured in China or abroad), with the number of vaccine doses administered. In addition, the risk of side-effects rather than serious side-effects was used to measure vaccine safety, as parents may be concerned about all adverse reactions of vaccination for their children, not just serious side-effects. Different levels for each of three attributes (efficacy, safety, and number of vaccine doses) were used to describe COVID-19 vaccines in the DCE (Appendix Table 1).

Appendix Table 1. COVID-19 vaccine attributes and levels

Attributes	Number of levels	Levels of attributes
Vaccine efficacy to reduce the infection risk	3	90% 70% 50%
Risk of adverse reactions	2	1/10 000 vaccinated people 1/1000 vaccinated people
Number of vaccine doses administered	2	1 dose 2 doses

Design of the DCE

The combination of the three attributes with each level resulted in 12 hypothetical vaccines and 66 possible choice tasks between any two hypothetical vaccines. A D-efficient discrete choice experimental design with vague priors for a multinomial logit model was created with SAS (version 9.4) software to reduce the number of choice tasks to eight (Appendix Table 2). The aim of the experimental design is to create a subset of all possible choice tasks that minimizes the determinant of the variance-covariance matrix for a given number of choice tasks. The experimental design specified to identify the main effects only of the three attributes which are included in a linear additive utility function in which vaccine efficacy had three levels, risk of adverse reactions had two levels, and number of vaccine doses had two levels. The model was specified to allow the attributes' levels to be included in a multinomial logit model as dummy variables. Vague priors were included in that specified the direction of expected preferences for each attribute: higher efficacy, lower risk of adverse reactions, and fewer number of vaccine doses were assumed to be preferred. A set of two candidate designs were created and the final design was then selected based on the best D-efficiency and D-error of the design and lowest burden of respondents.

Appendix Table 2. Eight choice tasks selected in the DCE

Choice task	Vaccine	Vaccine efficacy	Vaccine safety	Number of doses
1	A	50%	1/1000	1
	B	90%	1/10 000	2
2	A	90%	1/10 000	1
	B	70%	1/1000	2
3	A	70%	1/1000	2
	B	50%	1/10 000	1
4	A	70%	1/1000	1
	B	50%	1/10 000	2
5	A	50%	1/1000	2
	B	70%	1/10 000	1
6	A	50%	1/10 000	2
	B	90%	1/1000	1
7	A	90%	1/1000	2
	B	70%	1/10 000	1
8	A	50%	1/1000	1
	B	70%	1/10 000	2

Analysis of the DCE

The theoretical background for DCE analysis includes Lancaster's economic theory of value and random utility theory (Ryan, 2008). Lancaster's theory assumes that an individual derives utility from the underlying attributes or attributes of a commodity and that individual preferences are revealed through their choices (Lancaster, 1966). According to random utility theory, it is assumed that the utility acquired by an individual from a commodity can be decomposed into an explainable or systematic component and a non-explainable or random component (Manski, 1977). In our study, an individual's utility from a hypothetical vaccine can be expressed through the following equations:

$$U=V+\varepsilon=\beta_0+\beta_1*\text{Efficacy\_70\%}+\beta_2*\text{Efficacy\_90\%}+\beta_3*\text{Adverse\_reaction\_1/10 000}$$
$$+\beta_4*\text{Doses\_2dose}+\varepsilon \qquad \text{[Equation 1]}$$

where U is the utility that an individual gets from a hypothetical vaccine; V is the explainable component that is a function of the vaccine attributes; ε is a random component that represents unmeasured variation in preferences; β_0 is a constant reflecting an individual's preference for receiving a hypothetical vaccine to no vaccination; β_1 to β_4 are coefficients that show the relative importance of the attributes.

When the random component ε is assumed to be independent and identically distributed extreme value, the probability of respondents accepting a vaccine i from a set of J vaccine choices could be estimated by:

$$P_i=\exp(V_i)/\Sigma_J \exp(V_J) \qquad \text{[Equation 2]}$$

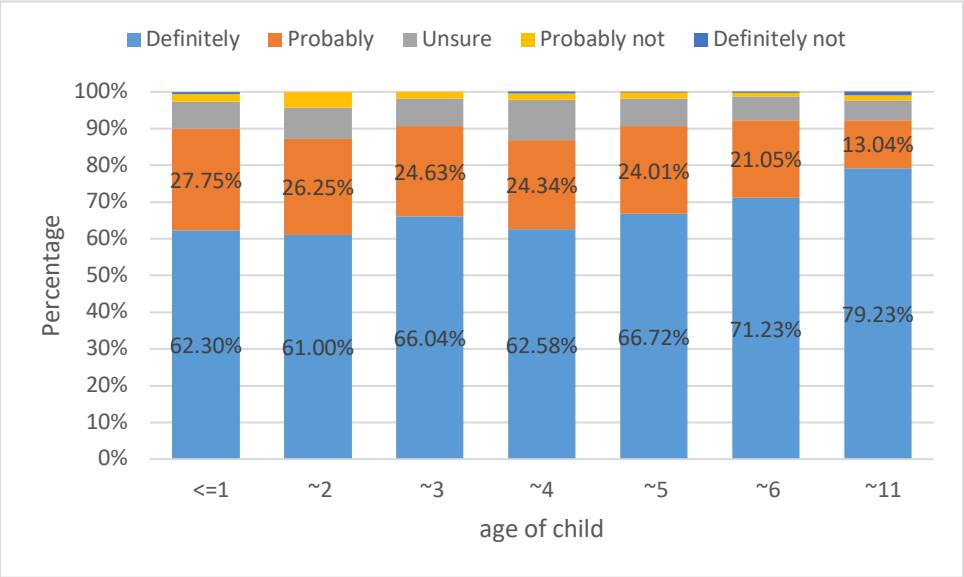
where V is defined in Equation 1.

In the analysis, odds ratios or coefficient means and their 95% confidence intervals (CIs) of vaccine attributes were estimated according to Equation 1. Probabilities and 95% CIs of vaccine acceptance are estimated according to Equation 2, and the detailed results were shown in Appendix Table 4 and Appendix Table 5.

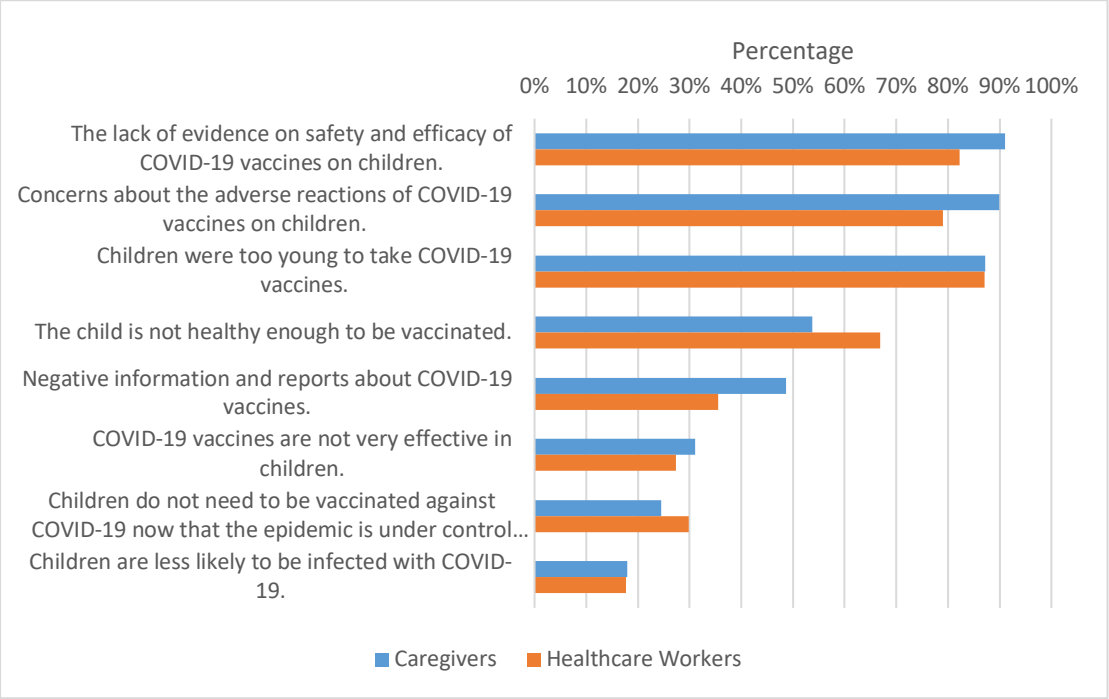
Reference

1. Lancaster, K. A new approach to consumer theory. Journal of Political Economy, 1966, 74: 132-157.
2. Manski, C. The structure of random utility models. Theory & Decision, 1977, 8(3): 229-254.
3. Ryan M, Gerard K, Amaya-Amaya M: Using Discrete Choice Experiments to Value Health and Health Care. Springer, 2008.

Appendix Figure 1. Childhood COVID-19 vaccine acceptance from caregivers by the age of their child



Appendix Figure 2. Reasons for childhood COVID-19 vaccine hesitancy



Appendix Table 3. Model with three COVID-19 vaccine attributes and caregiver interactions from Discrete Choice Experiment

Variables	Coefficient Means	95% Confidence Interval
Efficacy–70%[a]	1.39[e]	(1.31,1.46)
×Caregiver[b]	-0.32[e]	(-0.41,-0.22)
Efficacy–90%[a]	2.43[e]	(2.31,2.56)
×Caregiver[b]	-0.53[e]	(-0.68,-0.38)
Adverse reaction–1/10000[c]	1.08[e]	(1.01,1.16)
×Caregiver[b]	0.30[e]	(0.20,0.40)
Number of doses–2 doses[d]	0.07[e]	(0.03,0.11)
×Caregiver[b]	-0.01	(-0.06,0.03)
Constant	0.27[e]	(0.24,0.30)
Observations	62448	
Log likelihood	-14605.525	
Wald $\chi 2$(df)	4057.87(9)[e]	

[a] Reference category is Efficacy–50%.

[b] Reference category is Health care workers.

[c] Reference category is Adverse reaction–10/10000.

[d] Reference category is Number of doses–1 dose.

[e] Statistically significantly at $P < .001$ for a 2-tailed test.

Appendix Table 4. Predicted probability of acceptance for hypothetical COVID-19 vaccines among caregivers (95%CI)

Efficacy	Adverse reaction	Dose	Caregivers(n=2588)		
			Outright vaccine refusal	Vaccine hesitancy	Vaccine acceptance
50%	1/10000	2	2.82(2.67,2.98)	34.04	63.14(61.39,64.89)
70%	1/10000	2	2.82(2.67,2.98)	11.32	85.86(84.79,86.93)
90%	1/10000	2	2.82(2.67,2.98)	3.32	93.86(93.41,94.32)
50%	10/10000	2	2.82(2.67,2.98)	91.04	6.14(4.64,7.64)
70%	10/10000	2	2.82(2.67,2.98)	44.17	53.01(50.75,55.26)
90%	10/10000	2	2.82(2.67,2.98)	20.64	76.54(74.82,78.25)
50%	1/10000	1	2.82(2.67,2.98)	35.82	61.36(59.69,63.03)
70%	1/10000	1	2.82(2.67,2.98)	12.12	85.06(84.00,86.11)
90%	1/10000	1	2.82(2.67,2.98)	3.70	93.48(92.99,93.98)
50%	10/10000	1	2.82(2.67,2.98)	93.84	3.34(2.88,3.79)
70%	10/10000	1	2.82(2.67,2.98)	46.28	50.90(49.06,52.75)
90%	10/10000	1	2.82(2.67,2.98)	21.88	75.30(73.65,76.94)

Appendix Table 5. Predicted probability of acceptance for hypothetical COVID-19 vaccines among health care workers (95%CI)

Efficacy	Adverse reaction	Dose	Health care workers(n=1700)		
			Outright vaccine refusal	Vaccine hesitancy	Vaccine acceptance
50%	1/10000	2	1.47(1.00,2.17)	45.14	53.39(50.67,56.12)
70%	1/10000	2	1.47(1.00,2.17)	12.82	85.71(84.35,87.07)
90%	1/10000	2	1.47(1.00,2.17)	3.92	94.61(94.15,95.07)
50%	10/10000	2	1.47(1.00,2.17)	92.58	5.95(4.18,7.71)
70%	10/10000	2	1.47(1.00,2.17)	35.41	63.12(60.70,65.54)
90%	10/10000	2	1.47(1.00,2.17)	13.40	85.13(83.72,86.55)
50%	1/10000	1	1.47(1.00,2.17)	47.62	50.91(48.42,53.40)
70%	1/10000	1	1.47(1.00,2.17)	13.75	84.78(83.48,86.08)
90%	1/10000	1	1.47(1.00,2.17)	4.28	94.25(93.76,94.74)
50%	10/10000	1	1.47(1.00,2.17)	95.94	2.59(2.13,3.05)
70%	10/10000	1	1.47(1.00,2.17)	37.51	61.02(59.06,62.98)
90%	10/10000	1	1.47(1.00,2.17)	14.36	84.17(82.80,85.54)