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Why do parents willingness-to-pay to vaccinate their children against COVID-19? A real-world evidence in Taizhou, China

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ABSTRACT

Purpose: This population-based cross-sectional study was conducted to explore whether parents are willing to pay to vaccinate their children against COVID-19 in China.

Methods: With a self-administered online questionnaire, we investigated parents' willingness to pay for their children to be vaccinated against COVID-19 in Taizhou, China. Of the 1,845 parents who answered the structured questionnaire when they received an e-mail or e-poster invitation, 1788 samples with valid data underwent data analysis.

Results: A total of 66.1% of parents reported being willing to pay to inoculate their children with the COVID-19 vaccine. After adjustment for confounding factors, lower education level, one-child family (yes vs. no, OR = 1.35, 95%CI: 1.04–1.74), knowledge score of vaccination against COVID-19 (high vs. low, OR = 1.31, 95%CI: 1.01–1.69), awareness of the permitted use of the vaccine (yes vs. no, OR = 1.51, 95%CI: 1.16–1.97), and willingness to pay for a COVID-19 vaccine for themselves (yes vs. no, OR = 16.31, 95%CI: 12.59–21.14) were significantly associated with parents' willingness to pay for their children.

Conclusion: We found that a moderate proportion of parents reported unwillingness to pay for their child to be vaccinated against COVID-19. The results indicate that further detailed assessment and more health education planning are required to increasing parents' WTP for the vaccination of children in China.

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Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is a highly contagious respiratory pathogen.[1] Given the population-wide susceptibility to the virus, vaccination is the most effective measure to combat the COVID-19 pandemic.[2] Research led to the development of various coronavirus vaccines that are effective and safe against COVID-19 in children.[3,4] Countries such as China are increasing the administration of the COVID-19 vaccination. Since July 2021, the age of vaccination has been expanded to the population aged 12 years and over in China, and more recently to those aged 3 years and over.

Willingness to pay (WTP), a method for estimating the maximum amount individuals are willing to allocate to programs, services, and health technologies, can provide a reference for future vaccine demand projections and pricing.[5] WTP is a contingent valuation and includes a hypothetical investigation by directly asking subjects the maximum amount they are willing to pay for the commodity in question.[6] From the conceptual viewpoint, the WTP method assumes that subjects' well-being relies on both earnings and health. An individual's WTP is the maximum amount of money that they would pay for treatment that restores them to full health while maintaining the same level of health.[7] Although the COVID-19 vaccines are currently free of charge, a hypothetical situation was provided for parents with the continued epidemic and the payment of vaccines based on the contingent valuation method (CVM).[8]

Many studies estimated parents' WTP to their children's vaccination in various vaccines and study populations. In the United States, parents are willing to pay more for a COVID-19 vaccine for their children than themselves.[9] Figure 1 depicted the framework for studying the outcome variables. The factors of parental decisions to pay for vaccination their children are complex and multidimensional, including contextual determinants, safety and efficacy of the vaccine, the vaccination services, and individual determinants such as parents' knowledge, attitudes, and socio-demographics.[10–13] A cross-sectional survey with a sample of 2160 households in China had shown fathers and grandparents of children had a higher WTP for self-paid vaccines than their mothers, and the WTP decreased with age.[14] Recent survey carried out in six countries during the peak of the pandemic also suggested that mothers were less likely to enroll their child in a trial for COVID-19 vaccination.[15] It indicated that decisions made by mothers and fathers are likely to be different in vaccinating their children. Additionally, studies of WTP for vaccinations showed that parents were more willing to immunize their children if

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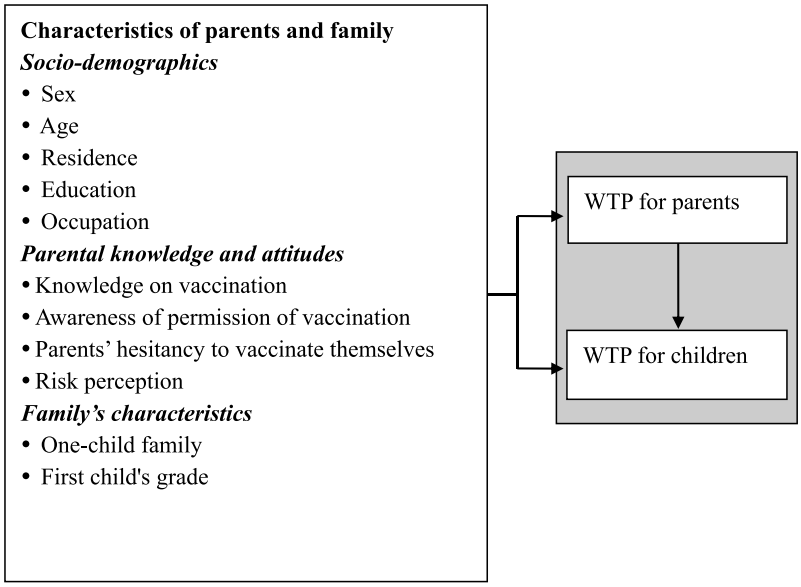

Figure 1. Framework for studying the outcome variables.

the vaccine is free or much less costly.[14,16] Our previous study found that a substantial proportion of parents were hesitant to vaccinate children against COVID-19.[17] These findings implied that parental attitudes toward future childhood COVID-19 vaccination and willingness to pay for the vaccine may also influence the success of future efforts to fully immunize children with the COVID-19 vaccine.

With the SARS-CoV-2 virus variation and the efficacy of the vaccine diminishes over time, the outbreak recurred constantly and more and more vaccine breakthrough infections were reported.[18] Thus, one full-schedule vaccination may not be enough for prevention COVID-19. Although the COVID-19 vaccine is now free in China, it may have to be paid for in the future because of limited healthcare resources. Therefore, it is important to understand parents' WTP for their children's COVID-19 vaccine and the factors that influence it.

Studies of the relationship between parental WTP for COVID-19 vaccination and WTP for COVID-19 vaccines for children are lacking. The purpose of this study was to examine whether parents are willing to pay for a COVID-19 vaccine for their children and the impact of Chinese parents' WTP for vaccination themselves on their WTP for the vaccine for their children under 18 years of age.

Methods

Study design and data collection

An anonymous cross-sectional population-based survey online was conducted via the WeChat-incorporated Wen-Juan-Xing platform (Changsha Ranxing Information Technology Co., Ltd., Hunan, China). Our target population was all parents who had at least one child under 18 years old. A convenient sample was selected to receive the invitation for the survey through WeChat. The interviewees voluntarily answered the self-administered questionnaire by scanning the Quick Response (QR) code on their mobile phones from 9 to 17 June 2021. Their participation in the survey was considered as informed consent. We didn't ask for a separate written informed consent because of anonymity. This study was approved by the Ethics Committee of Taizhou Hospital of Zhejiang Province (approval number: K20210520) in China. All procedures were performed in accordance with the guidelines of our institutional ethics committee and adhered to the tenets of the Declaration of Helsinki. All participants' information was anonymous.

Structured questionnaires and assessment of willingness-to-pay values

We designed a self-administered questionnaire based on previous studies[19] and frameworks on assessing WTP for vaccination against infectious diseases such as pneumococcal conjugate vaccine and influenza vaccine.[14] In order to ensure that the formal questionnaire is comprehensive, scientific and unambiguous, the initial questionnaire is tested and then revised based on the feedback from the test population.

The questionnaire asked questions to collect the following information: (1) basic demographic information, such as age, sex, residence, education, occupation, and the number of children under 18 years in the family; (2) high or low risk perception of COVID-19 as measured by: "How do you perceive the risk of the SARS-CoV-2?" (five items: very high, high, general, low, and very low); (3) knowledge about vaccination against COVID-19 was measured by a question: "Do you think it is suitable to inoculate the COVID-19 vaccine under the following 22 conditions?" (three items: yes, no or unclear). The 22 conditions are detailed elsewhere.[17] The score of knowledge is expressed as the percentage of correct answers to 22 questions, and participants were divided into two groups (≤36.4 and >36.4) according to median of the knowledge score. Attitudes toward the COVID-19 vaccine were tested by the questions "Are you hesitant to take the COVID-19 vaccine (whether you are vaccinated or not)?" (four items: very hesitant, hesitant, unhesitant, or very unhesitant); (4) parents' willingness to pay

for a COVID-19 vaccine for themselves was measured by two questions: "Would you like to be vaccinated if you have to pay for the COVID-19 vaccine?"(two items: yes or no) and "How much would you be willing to pay for the COVID-19 vaccine for yourself?" (seven items: <100, 100 ~ 199, 200 ~ 299, 300 ~ 399, 400 ~ 499, 500 ~ 599, or ≥600 Chinese Yuan (CNY)); (5) then, a question regarding parents' willingness to pay for the COVID-19 vaccine for their children was also asked. Almost all of the questions were closed, with checkboxes provided for responses.

Quality control

Firstly, the preface of the questionnaire introduces the background, purpose and content of the questionnaire, and explains that the questionnaire will be filled in anonymously and completed voluntarily after informed consent. Secondly, we set up a reminder to check the integrity of questionnaire to make sure that each questionnaire is completely filled and there are no missing items. Thirdly, a logical check was performed and outliers were eliminated before data analysis. Parents who were under 18 or over 80 years of age would be excluded. The time taken to complete the questionnaire was converted logarithmically, and if it exceeded mean ± 3SD, it was considered an outlier and was also excluded from the analysis. Finally, 1788 questionnaires underwent data analysis, and the average time to complete the questionnaire was 876 seconds and the median was 753 seconds (ranging from 168 to 2472 seconds).

Literature search strategy

A search was performed in The Cochrane Library, PubMed and EMBASE databases for relevant studies from inception to 31 July 2021. Searches included a mix of MeSH and free-text terms related to the key concepts of willingness to pay, parents, children and vaccines with no language restrictions. After filtering out the irrelevant literature and removing the duplicate literature by scanning the titles and abstracts, 16 related literatures were finally obtained. We extracted the following data from included studies using a data-extraction form: first author, study design, study period, sample size, country, type of vaccines, and the proportion and amount of willingness to pay.

Statistical analysis

The primary outcome of the survey was parents' willingness to pay for a COVID-19 vaccine for their children. Counts and frequency distributions are displayed for classified data and χ^2 (chi-square) tests were used to compare the differences between the unwilling-to-pay group and willing to pay group. The potential factors associated with parents' willingness to pay for their children, such as sex, age, residence, education, occupation, risk perception of COVID-19, and knowledge and attitudes about the COVID-19 vaccine were initially assessed using the chi-square test.

Binary logistic regression was then performed to identify the factors associated with parents' willingness to pay for the vaccine for their children, with the odds ratio (OR) and a 95% confidence interval (CI) being calculated. Variables that were significant at the $P < .05$ level in the univariate analyses were included in the model. All data were analyzed by IBM SPSS statistics 22.0 software (SPSS Inc., Chicago, IL, USA). A P-value of <0.05 was considered to represent a statistically significant difference among the test populations.

Results

Of the 1,845 parents who answered our questionnaire, 54 were excluded due to parents' age under 18 or over 80 years, and 3 were excluded because of too short (less than 120 seconds) or too long (more than 2490 seconds) time to complete the questionnaire. Finally, 1788 samples with valid data were included in this study.

Relationship between parents' WTP for themselves and parents' WTP for their children

Of the study population, 38.3% (685/1788) parents were unwilling to pay for a COVID-19 vaccine for themselves, 61.7% (1103/1788) were willing to pay and the price accepted by most (92.1%, 1016/1103) was below CNY 200. Similarly, 33.9% (606/1788) parents would be unwilling to pay for their children, while 66.1% (1182/1788) reported being willing to pay, and the price accepted by most (91.5%, 1082/1182) was less than CNY 200. Among parents who were unwilling to pay for a COVID-19 vaccine for themselves, 68.9% (472/685) were also unwilling to pay for their children, but 31.1% (213/685) were willing to pay for their children. Among parents who were willing to pay for themselves, 87.9% (969/1103) were also willing to pay for their children, but 12.1% (134/1103) were unwilling to pay for their children (Figure 2). The relationships between parents' WTP for themselves and parents' WTP for their children were significant ($P < .001$) both in fathers and mothers.

Factors associated with parental WTP for vaccination their children against COVID-19

Table 1 shows that parents' WTP for a COVID-19 vaccine for their children was related to parents' age ($t = 3.906$, $P < .001$), residence ($\chi^2 = 9.156$, $P = .01$), education level ($\chi^2 = 21.988$, $P < .001$), one-child family ($\chi^2 = 4.678$, $P = .031$), first child's grade ($\chi^2 = 16.341$, $P = .001$), knowledge score of vaccination against COVID-19 ($t = 3.203$, $P < .001$), awareness about the permitted use of the vaccine ($\chi^2 = 14.137$, $P < .001$), and hesitancy to receive vaccines against COVID-19 ($\chi^2 = 57.905$, $P < .001$).

Like parents, mothers' WTP for a COVID-19 vaccine for their children was also related to their age ($t = 2.889$, $P = .004$), residence ($\chi^2 = 8.107$, $P = .017$), education level ($\chi^2 = 23.313$, $P < .001$), one-child family ($\chi^2 = 6.195$, $P = .013$), first child's grade ($\chi^2 = 15.189$, $P = .002$), knowledge score of vaccination against COVID-19 ($t = 3.244$, $P = .001$), awareness of the permitted use of the vaccine ($\chi^2 = 11.138$, $P = .001$), and hesitancy to receive vaccination against COVID-19 ($\chi^2 = 48.014$, $P < .001$).

Fathers' age ($t = 2.353$, $P = .019$) and hesitancy to receive vaccination against COVID-19 ($\chi^2 = 8.823$, $P = .003$) also differed among the unwilling-to-pay group and willing to pay group for their children.

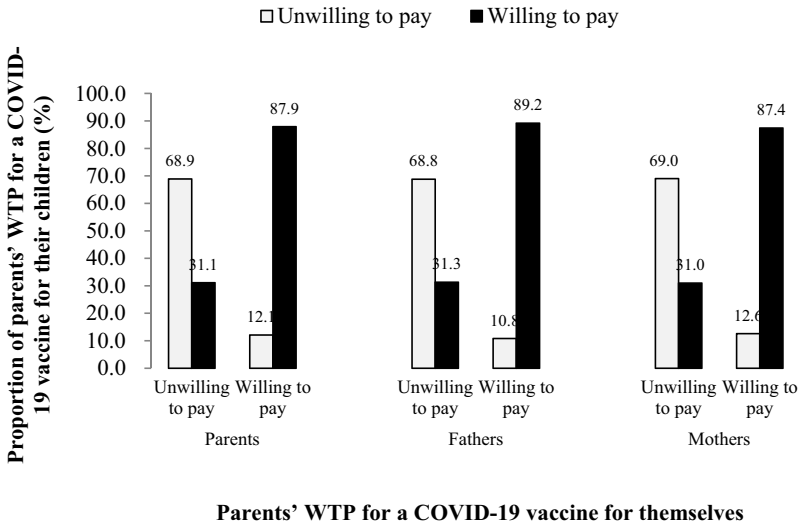

Figure 2. Association between parents' willingness to pay for vaccination themselves and willingness to pay for vaccination their children.

The effect of independent factors on parents' willingness to pay for a COVID-19 vaccine for their children was examined using a binary logistic regression model. As depicted in Table 2, after adjustment for confounding factors, lower education level, one-child family (yes vs. no, OR = 1.35, 95%CI: 1.04–1.74), knowledge score of vaccination against COVID-19 (high vs. low, OR = 1.31, 95%CI: 1.01–1.69), awareness of the permitted use of the vaccine (yes vs. no, OR = 1.51, 95%CI: 1.16–1.97), and willingness to pay for a COVID-19 vaccine for themselves (yes vs. no, OR = 16.31, 95%CI: 12.59–21.14) were significantly associated with parents' willingness to pay for their children.

After stratifying by sex, risk factors associated with mothers' willingness to pay were similar to those for parents as a whole. Notably, both mothers' and fathers' willingness to pay for themselves strongly influenced their willingness to pay for their children.

Factors associated with parental WTP for vaccination themselves

To further explore the factors that influence parents' willingness to pay for themselves, binary logistic regression model was also conducted after the potential variables identified in the chi-square or *t* tests ($P < .05$). As shown in Table 3, parents' willingness to pay for themselves was affected by hesitancy to receive vaccination against COVID-19 (no vs. yes, OR = 2.72, 95%CI: 2.23–3.32) and knowledge on vaccination against COVID-19 (high vs. low, OR = 1.52, 95%CI: 1.24–1.86). The factors of maternal WTP were consistent with total population, while fathers' WTP was not only related to vaccine hesitation, but also to age and risk perception of COVID-19.

We also found that the main reason for parental hesitancy to vaccinate was concern about the safety of the vaccine, followed by personal health reasons. Given that vaccine hesitancy could decrease parental WTP for vaccination themselves, the reasons for vaccine hesitancy may largely reflect the reasons for unwillingness to pay.

The estimates of parents' WTP for vaccination children in various vaccines and study populations

We summarized the different estimates of parents' WTP for their children's vaccination in various vaccines and study populations in Table 4. The estimates of WTP ranged from 50% to 97%. This estimated disparity likely occurred due to differences between study populations in addition to discriminations in the specifics of the vaccinations. The results of this study showed that 66.1% of parents were willing to pay for a COVID-19 vaccine for their children, which was in line with previous findings.

Discussion

Clinical implications

The benefit to a recipient of a medical service or intervention is viewed as the maximum value one is willing to pay for the service or intervention based on welfare economic theory.[6] The benefit to society of the intervention is the summary of each recipient's WTP value.[35] Evaluation of WTP values, as an instrument to determine parents' satisfaction with COVID-19 vaccination of children, can help to explain how much a father or mother values a vaccination, and whether and how much parents would pay to receive a special preventive strategy. One inevitable disadvantage of WTP analysis is that it is completely hypothetical. Regardless of the subject's response to the questionnaire, the participants' actual actions may differ. Economic evaluation of health and health care showed an increasing interest in the application of WTP questionnaires as an instrument to determine health benefits.[36]

The literature review presented the different estimates of parents' WTP to their children's vaccination in various vaccines and study populations.[9,20–34] This estimated disparity likely occurred due to differences between study populations in addition to discriminations in the specifics of the vaccinations. This study was conducted to investigate the willingness

Table 1. Univariate analysis of factors associated with parents' willingness to pay for a COVID-19 vaccine for their children (n = 1788).

		Parents (n = 1788)			Fathers (n = 448)			Mothers (n = 1340)		
Variables	Categories	Willingness to pay (n = 1182)	Unwillingness to pay (n = 606)	P	Willingness to pay (n = 307)	Unwillingness to pay (n = 141)	P	Willingness to pay (n = 875)	Unwillingness to pay (n = 465)	P
Sex	Men	307 (26.0)	141 (23.3)	.211	307 (100.0)	141 (100.0)	/	/	/	/
	Women	875 (74.0)	465 (76.7)		/	/		875 (100.0)	465 (100.0)	
Age (years)*		42.0 ± 5.4	41.0 ± 4.9	**<.001**	43.9 ± 5.5	42.6 ± 5.2	**.019**	41.4 ± 5.3	40.5 ± 4.7	**.004**
Residence	Rural	286 (24.2)	110 (18.2)	**.010**	84 (27.4)	32 (22.7)	.577	202 (23.1)	78 (16.8)	**.017**
	Town	227 (19.2)	116 (19.1)		56 (18.2)	27 (19.1)		171 (19.5)	89 (19.1)	
	Urban	669 (56.6)	380 (62.7)		167 (54.4)	82 (58.2)		502 (57.4)	298 (64.1)	
Education level	Junior Secondary and below	379 (32.1)	145 (23.9)	**<.001**	86 (28.0)	35 (24.8)	.268	293 (33.5)	110 (23.7)	**<.001**
	Senior Secondary	276 (23.4)	136 (22.4)		81 (26.4)	28 (19.9)		195 (22.3)	108 (23.2)	
	Junior College	223 (18.9)	111 (18.3)		46 (15.0)	26 (18.4)		177 (20.2)	85 (18.3)	
	Undergraduate and above	304 (25.7)	214 (35.3)		94 (30.6)	52 (36.9)		210 (24.0)	162 (34.8)	
Occupation	Civil servant or professional technician or serviceman	204 (17.3)	122 (20.1)	.276	77 (25.1)	41 (29.1)	.751	127 (14.5)	81 (17.4)	.317
	Employees and managers of enterprises	266 (22.5)	149 (24.6)		71 (23.1)	36 (25.5)		195 (22.3)	113 (24.3)	
	Workmen or farmer	164 (13.9)	67 (11.1)		48 (15.6)	16 (11.3)		116 (13.3)	51 (11.0)	
	Freelancer	186 (15.7)	82 (13.5)		29 (9.4)	15 (10.6)		157 (17.9)	67 (14.4)	
	Self employed	207 (17.5)	106 (17.5)		59 (19.2)	23 (16.3)		148 (16.9)	83 (17.8)	
	Others	155 (13.1)	80 (13.2)		23 (7.5)	10 (7.1)		132 (15.1)	70 (15.1)	
One-child family	Yes	610 (51.6)	280 (46.2)	**.031**	158 (51.5)	73 (51.8)	.952	452 (51.7)	207 (44.5)	**.013**
	No	572 (48.4)	326 (53.8)		149 (48.5)	68 (48.2)		423 (48.3)	258 (55.5)	
First child's grade				**.001**			.636			**.002**
	Primary below grade 3	160 (13.5)	110 (18.2)		44 (14.3)	26 (18.4)		116 (13.3)	84 (18.1)	
	Primary grade 4–6	182 (15.4)	111 (18.3)		41 (13.4)	20 (14.2)		141 (16.1)	91 (19.6)	
	Junior school	276 (23.4)	153 (25.2)		68 (22.1)	32 (22.7)		208 (23.8)	121 (26.0)	
	Senior school	564 (47.7)	232 (38.3)		154 (50.2)	63 (44.7)		410 (46.9)	169 (36.3)	
Risk perception of COVID-19				.319			.369			.594
	High risk	125 (10.6)	55 (9.1)		42 (13.7)	15 (10.6)		83 (9.5)	40 (8.6)	
	Low risk	1057 (89.4)	551 (90.9)		265 (86.3)	126 (89.4)		792 (90.5)	425 (91.4)	
Score of knowledge about vaccination against COVID-19*		44.7 ± 28.1	40.2 ± 28.2	**.001**	43.4 ± 30.0	40.7 ± 30.9	.375	45.1 ± 27.4	40.0 ± 27.4	**.001**
Are you aware that COVID-19 vaccine has been approved for emergency use in children under 18 years?										
	Yes	857 (72.5)	387 (63.9)	**<.001**	235 (76.5)	98 (69.5)	.113	622 (71.1)	289 (62.2)	**.001**
	No	325 (27.5)	219 (36.1)		72 (23.5)	43 (30.5)		253 (28.9)	176 (37.8)	
Parents' hesitancy to receive vaccines against COVID-19										
	Yes	459 (38.8)	350 (57.8)	**<.001**	91 (29.6)	62 (44.0)	**.003**	368 (42.1)	288 (61.9)	**<.001**
	No	723 (61.2)	256 (42.2)		216 (70.4)	79 (56.0)		507 (57.9)	177 (38.1)	

Data were expressed as number followed by proportion in the parentheses within parents' willingness or unwillingness.

* Data on age and score of knowledge about vaccination against COVID-19 were continuous, expressed as mean ± standard deviation (SD), and compared the differences between willingness group and unwillingness group using t-test.

Table 2. Multiple logistic regression of factors associated with parents' willingness to pay for a COVID-19 vaccine for their children (n = 1788).

		Parents		Fathers		Mothers	
Variables	Categories	*P*	*OR* (95%*CI*)	*P*	*OR* (95%*CI*)	*P*	*OR* (95%*CI*)
Age (years)*		.729	0.99 (0.96–1.03)	.267	1.03 (0.98–1.08)	.329	0.98 (0.95–1.02)
Residence							
	Rural vs. urban	.245	1.24 (0.86–1.79)	/	/	.192	1.33 (0.87–2.03)
	Town vs. urban	.530	1.11 (0.80–1.55)	/	/	.775	0.95 (0.65–1.38)
Education level	Junior Secondary and below	**<.001**	2.45 (1.63–3.68)	/	/	**<.001**	2.43 (1.53–3.84)
	Senior Secondary	**<.001**	2.16 (1.49–3.12)	/	/	**.003**	1.88 (1.23–2.87)
	Junior College	**<.001**	1.93 (1.33–2.79)	/	/	**<.001**	2.07 (1.35–3.16)
	Undergraduate and above	/	1	/	/	/	1
One-child family	Yes vs. no	**.022**	1.35 (1.04–1.74)	/	/	**.002**	1.58 (1.18–2.13)
First child's grade	Primary below grade 3 vs. senior school	.155	0.72 (0.45–1.13)	/	/	**.026**	0.55 (0.32–0.93)
	Primary grade 4–6 vs. senior school	.911	1.02 (0.67–1.56)	/	/	.631	0.89 (0.55–1.43)
	Junior school vs. senior school	.252	0.82 (0.58–1.15)	/	/	.129	0.74 (0.50–1.09)
Score of knowledge about vaccination against COVID-19*							
	High vs. low	**.041**	1.31 (1.01–1.69)	/	/	.051	1.34 (0.99–1.80)
	Yes vs. No	**.003**	1.51 (1.16–1.97)	/	/	**.006**	1.53 (1.13–2.07)
Parents' hesitancy to receive vaccines against COVID-19							
	No vs. Yes	.083	1.25 (0.97–1.61)	.808	0.94 (0.55–1.59)	**.037**	1.36 (1.02–1.82)
Parents' willingness to pay for a COVID-19 vaccine for themselves							
	Yes vs. No	**<.001**	16.31 (12.59–21.14)	**<.001**	18.12 (10.77–30.49)	**<.001**	15.35 (11.41–20.64)

Table 3. Multiple logistic regression of factors associated with parents' willingness to pay for a COVID-19 vaccine for themselves that all univariate significant factors were included among study samples (n = 1788).

		Parents		Fathers		Mothers	
Variables	Categories	*P*	*OR* (95%*CI*)	*P*	*OR* (95%*CI*)	*P*	*OR* (95%*CI*)
Age (years)	/	.059	1.02 (0.99–1.04)	**.029**	1.04 (1.00–1.08)	.375	1.01 (0.99–1.03)
Score of knowledge about vaccination against COVID-19	High vs. Low	**<.001**	1.52 (1.24–1.86)	.221	1.29 (0.86–1.96)	**<.001**	1.59 (1.26–2.01)
Risk perception of COVID-19	High vs. Low	.468	0.88 (0.62–1.25)	**.043**	0.48 (0.23–0.98)	.641	1.10 (0.73–1.66)
Parents' hesitancy to receive vaccines against COVID-19	No vs. Yes	**<.001**	2.72 (2.23–3.32)	**<.001**	2.73 (1.80–4.14)	**<.001**	2.78 (2.20–3.50)

to pay for children's vaccination against COVID-19 in a parental population in China. We thought that a WTP questionnaire would help with setting the most acceptable price for a COVID-19 vaccination for children at risk. In this study, 33.9% of parents did not want to pay a COVID-19 vaccination fee for their children, indicating that they did not believe that COVID-19 infection would limit their children's quality of life. WTP values were statistically significantly higher in parents with a low education level and a high score of knowledge about vaccination against COVID-19. This implied that parents with a lower level of education or higher background knowledge were more likely to pay for desirable attributes, and to pay greater amounts. More educated parents may place greater value on convenience and absence of adverse effects, or they may have possessed a better understanding of the diminishing efficacy of COVID-19 vaccination.

One interesting finding is that a higher WTP for children's vaccination was found in one-child families. When parents make decisions about vaccinations for their children, the budgetary restrictions may be significant, particularly if the parents are self-paying and have a larger household size. This income and price effect may be determined by health interests, where having more unvaccinated children may improve the probability of transmitting the virus in the household.[9] In addition, our findings help with evaluating parents' valuation of the hazard for themselves and their children when the health disturbance is not a hypothetical outbreak but a real-world pandemic. The assessment of data collected during the COVID-19 outbreak reveals essential traits about the factors related to parents' acceptance of a vaccine given discrepancies in age, income, perceived hazard, and individual WTP for vaccines.

Clinical practices

The current study showed that 61.7% of parents were willing to pay for themselves, and 66.1% were willing to pay for their children for a COVID-19 vaccine, and the price accepted by most was below CNY 200 (USD 31.4). The findings reflected the economic valuation and affordability for future vaccination.

We also found the different influencing factors of WTP for their children between fathers and mothers. The relatively high WTP for COVID-19 vaccination for their children was related to low level of mothers' education, having only one child, know more about vaccination against COVID-19, awareness about the permitted use of the vaccine, and mothers' no hesitation to receive the vaccine. Most importantly, it has to do with the WTP that mothers and fathers provide for themselves. Further study should be considered to assess the reasons for parental unwillingness to pay for vaccination themselves.

In order to increase people's willingness to receive and pay for the COVID-19 vaccine for children, the following intervention measures could be considered. First, the government could consider modest subsidies, especially for low- and middle-income households. Second, the cost of vaccine procurement should be reduced so that more families can afford it. Third, more public health efforts could be made to improve

Table 4. The estimates of parents' willingness-to-pay to children vaccination in various vaccines and study populations.

						Willingness to pay		
Author	Study design	Study period	Study sample	Country	Vaccine	Percent	Mean/Median	Reference
Catma et al.	Cross-sectional	2021	Total:584	USA	COVID-19	NA	mean:US $243-$321	[9]
Rezaei et al.	Cross-sectional	2019	Mother:667	Iran	compulsory vaccination	Mother:93.1%	mean:US $4.4	[20]
Lai et al.	Cross-sectional	2019	Total:6668	China	Influenza	Total:92.8%	mean: CNY $127.5median:CNY $ 150	[21]
Wagnew et al.	Cross-sectional	2019	Total: 604	Ethiopia	Malaria	Total:60.6%	mean:US $23.11	[22]
Olson et al.	Cross-sectional	2015–2016	Total:564	Guatemala	Norovirus	Total:97%	$0–$3.40:54%$3.40–$6.80:30%$6.80–$10.20:5%$10.20–$13.60:6%> $13.60:5%	[23]
Hadisoemarto et al.	Proportional odds model interval regression model	2010	Total:500	Indonesia	Dengue	Total:94.6%	mean:US $36.8 median:US $1.94	[24]
Iwashita et al.	Cross-sectional	2010	Total:549	Japan	Hib	Total:50.3%	mean:JPY$2581	[25]
Muangchana et al.	Cross-sectional	2006	Mother:662	Thailand	Hib	Mother:50%	median:THB $3800(US$106)	[26]
Prosser et al.	Cross-sectional	2015	Total:101	USA	Pneumococcal Conjugate	NA	median:US$100 – US$500	[27]
Dinh et al.	Cross-sectional	2017	Mother:606	Vietnam	HPV	Mother:53.1%	>US $ 23:55.6%US $ 23-US $46:36.3%US $ 46-US $92:8.1%	[28]
Umeh et al.	Cross-sectional	2015	Mother:438	Nigeria	HPV	Mother:91.6%	mean:US $11.68WTP per dose:mean:US $ 5.84 median:US $ 5.03a dose US$ 5.03:50%	[29]
Ngorsuracheset al.	Discrete choice experiment (DCE)	2014	Total: 314	Thailand	HPV	NA	quadrivalent vaccine:Father:mean Baht$ 19260.5Mother:mean Baht$ 24493.1 bivalent vaccine:Father:mean Baht$ 9936.5 Mother:mean Baht$ 12,325.1	[30]
Kruiroongroj et al.	Cross-sectional	2014	Total:861	Thailand	HPV	Total:Bivalent 68.9% Quadrivalent 67.3%	3 doses of bivalent vaccine:N = 445<500 baht 159(35.8%) ≥500 baht 286 (64.3%)quadrivalent vaccine:N = 384Similar to bivalent vaccine 149 (38.8%)Higher than bivalent vaccine 235 (61.6%)	[31]
Cerda et al.	Contingent valuation method	2013	Total:386	Chile	HPV	Total:75%	mean:US $252.71	[32]
Brown et al.	Choice-format, conjoint-analysis survey	2008	Mother:307	USA	HPV	NA	mean:US $560-$660	[33]
Liao et al.	Cross-sectional	2007	Mother:476	Taiwan (China)	HPV	NA	median:US$1098 – US$1233	[34]

NA, not available.

parents' knowledge about the vaccine and vaccination, so as to reduce parents' vaccine hesitancy. Health education and promotion have a long way to achieve vaccine-related herd immunity in whole population as soon as possible.

Methodological considerations

There were several methodological strengths in this study. Firstly, the WTP instrument includes a valuation of the profits in the same unit as the costs, which is needed to enable medical decision makers to efficiently assign resources and increases the potential of capturing all corresponding patients, opinions, and value benefits of a preventive intervention. Secondly, a population-based study with a relatively larger sample size is more likely to decrease selection bias. Thirdly, we controlled for other possible COVID-19 vaccine related factors that might have biased estimates of the WTP for children vaccination using a logistic regression model.

However, this study had some limitations. First of all, Taizhou is only one area of China. The study population is selected on a convenient and voluntary basis. It would potentially introduce selection bias such as volunteer bias. Therefore, the results may not be representative, that is, the findings have low generalizability. Secondly, we measured perception of disease risk directly by one question "How do you perceive the risk of the SARS-CoV-2?" not by the severity and clinical manifestations of the disease in the past. Thirdly, the factors such as family economic status, parents' health concept, children's own physical condition and average age of children did not be obtained. First child's grade may partly reflect average age of children, but we can not analyze the other factors. Fourthly, we examined the link between parents' WTP for their own vaccinations and their WTP for their children's vaccinations. However, the questionnaire did not investigate why parents were reluctant to pay for vaccination for themselves or their children. The reasons for parents' WTP should be addressed in future studies to guide the development of targeted interventions to increase immunization coverage rate, thereby improving the practicability and comprehensiveness of the research. In addition, social desirability bias may have occurred when participants answered with socially beneficial choices. Due to the limited survey time, we could not accurately determine the precise WTP values for children vaccination of each parent. Finally, during the period of the questionnaire survey, the COVID-19 outbreak in Taizhou was under control, and cases are sporadic across the country. Furthermore, our estimates were conducted at only a single time point, so neither the impact of rush of the outbreak on people's WTP for vaccination, nor the long-term trend in WTP values could be determined. Further epidemiological and longitudinal investigations are essential to further understand the risk perception and WTP to decrease the potential health risks of COVID-19 vaccines.

Conclusion

In conclusion, our findings showed that a moderate proportion of parents reported that they are unwilling to pay for their child to be vaccinated against COVID-19. The findings indicated the necessity of detailed assessments and further health education planning to increase parents' WTP for the vaccination of their children in China. Public policy programs require a comprehensive cost–benefit analysis and an understanding of the WTP for children's COVID-19 vaccinations to judge the interests in the appropriate treatment or vaccine to decrease the risk of repeated widespread outbreaks.

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Data sharing statement

All data underlying the findings are within the paper.

Ethics approval and consent to participate

A convenient sample was selected to receive the invitation for the survey. An anonymous self-administered questionnaire was voluntarily answered. We didn't ask for a separate written informed consent because of anonymity. Parental participation in the survey was considered as informed consent. This study was approved by the Ethics Committee of Taizhou Hospital of Zhejiang Province (approval number: K20210520) in China.

Author contributions

J.S. Z. and T.H.T. conceived the study. M.X.Z., J.S. Z. and T.H.T. designed the questionnaire. J.S. Z. collected the data. M.X.Z. was responsible for the coding of the analyses. T.H.T. and M.X.Z. analyzed and interpreted the data, and wrote the first draft of the paper. X.Q.L and Y.C. searched, sorted and interpreted the relevant literature. All authors edited and approved the final manuscript.

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