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Research Article

Constructed Recognition: How Nationalism Influences Public Acceptance of Domestic COVID-19 Vaccines in China

Yanyu Ye[1], Qian Zhou[2], Zhenhua Su[3], Zheng Gu[4*]

[1]Hangzhou City University, Hangzhou, Zhejiang Province, China

[2]College of Humanities and Foreign Languages, China Jiliang University, Hangzhou, China

[3]College of Media and International Culture, Zhejiang University, Hangzhou, Zhejiang Province, China

[4]School of Public Affairs, Zhejiang University, Hangzhou, Zhejiang Province, China

[*]**Corresponding author:** Zheng Gu, School of Public Affairs, Zhejiang University, Hangzhou, Zhejiang Province, China

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Abstract

Background: Despite numbers of vaccine scandals and the potential side effects, COVID-19 vaccines have gained widespread acceptance in China shortly after approved by National Medical Products Administration. The purpose of the study was to explain why support of vaccines is so high in China. **Methods:** Based on existing literature, we proposed three possible motivating factors for respondents' perceptions of COVID-19 vaccines: individuals' risk perception of the disease, the sense of altruism and the nationalistic ideology. Drawing on data from a survey conducted in May of 2021, we examined the three hypotheses by using ordered logit models. Moreover, we explored how individuals' trust in scientists influences their acceptance of domestic COVID-19 vaccines and discussed the relationship between nationalism and the trust in scientists. **Results:** 2038 participants completed our questionnaire online (females=48.72%). We found that respondents' risk perception and sense of altruism can partially explain public's positive opinions on COVID-19 vaccines. The main finding of this paper is that the nationalism is the important source of the trust in the new vaccines, since the Chinese government has repeatedly emphasized the relevance of the COVID-19 vaccines to the national interests. Trust in Chinese scientists is the dominating factor to inspire public's acceptance of COVID-19 vaccines in China, which can also be considered as a derivative of nationalism, for the reputations of the medical experts are deliberately constructed by the government during the epidemic. **Conclusion:** Though the information of COVID-19 vaccines is lack of transparency and not accessible to the public, Chinese people still highly trust in the quality of the vaccines. Our research finds that the high recognition of the newly developed vaccines is a product of the nationalistic ideology and deliberately constructed by the Chinese government during the epidemic.

Keywords: COVID-19; Perceived safety of vaccines; Perceived effectiveness of vaccines; Nationalism; Trust in scientists; Risk perception; Altruism

Introduction

Over the last few years, a number of disturbing incidents have been reported in China, which have raised serious doubts about the quality of domestic vaccines. In 2013, in Hengyang, Hunan province, three infants suffered severe adverse reactions after receiving hepatitis B vaccinations, leading to the deaths of two of them. Subsequently, the rate of hepatitis B vaccination among children immediately dropped by 30% [1,2]. In March 2016, suspects were charged with illegally selling improperly stored vaccines worth more than 570 million yuan, which has affected 24 provincial-level regions since 2011 [3]. In 2018, it was revealed that Changsheng Biotechnology Company had fabricated production and inspection records and 252,600 unqualified DTP vaccines had been injected into children, triggering a nationwide panic that led to even greater skepticism [4,5] Unsurprisingly, these incidents shook the public's confidence in the vaccine system [6].

Under normal circumstances, it takes nearly 10 years to release a new vaccine to market from initial research [7]. Compared to other vaccines, in response to the rapid spread of the virus, the time of development for the COVID-19 vaccine was significantly shortened. Because of this rushed timeline, none of the vaccines in China have completed phase III clinical trials and have only been approved for emergency use. As of February 2021, the European, US, and Taiwan CDCs had reported hundreds of vaccine-related deaths. Though Chinese authorities have not publicly disclosed any detailed information on the safety of domestic vaccines, some foreign media sources have reported deaths from Sinopharm or Sinovac vaccines. This implies that the current COVID-19 vaccines remain associated with potential risks. Before the epidemic, China had lagged behind Europe and the U.S. in vaccine research and distribution, including those for MMR, HPV, and influenza [8]. In the case of COVID-19, when the government granted emergency approval for domestic vaccines and began promoting vaccination of the public in the early 2021, little was known about safety and effectiveness.

Without adequate information on COVID-19 vaccines and sufficient confidence in the vaccines system, however, many surveys conducted at various stages of the pandemic have shown that Chinese people strongly believe in the effectiveness of domestic COVID-19 vaccines [4,5,9]. As of April 14, 2021, the total number of doses administered per 100 people reached 229.09, with 25 million daily vaccinations at the peak, resulting in China being ranked as the most vaccinated country in the world. Similarly, our survey, conducted in May 2021, showed that more than 90% of Chinese people "strongly agree" or "somewhat agree" that the domestic COVID-19 vaccines are both safe and effective, which is significantly higher than other countries [10].

One possible explanation is related to self-interest, which refers to people's risk perception in this article. Specifically, the higher one's risk perception of COVID-19, the higher his/her willingness to be vaccinated. In the early stages of the epidemic, the high infection rate and the lack of knowledge regarding diagnosis and treatment caused a run on medical resources and crashed the health care system in Wuhan, bringing about a serious public health crisis and causing severe panic across the country. Thus, to avoid becoming infected, people were willing to accept the new vaccines.

Another possible explanation is related to altruism. Vaccination is not just an act of self-preservation stemming from self-interest, it is also an act of altruism. When vaccination rates reach 80% or more, herd immunity can be achieved, which will protect others and prevent large-scale outbreaks [11,12]. Increasing vaccination coverage can help protect those who are not eligible for vaccination by reducing their likelihood of infection [13]. Thus, sense of altruism can encourage the willingness to cooperate and increases the likelihood of accepting new vaccines. The effects of these two motivations on vaccination attitudes have been widely discussed in the existing literature [14-18].

In addition, as the mainstream ideology in China, nationalism is a major force behind vaccine acceptance. For a long time, the Chinese government has been sparing no effort to imbue the public with values such as patriotism, obedience to the government, sacrifice for the benefit of the nation, etc., which has profoundly affected the people's beliefs and actions. Especially after the outbreak of the virus, slogans like "Everyone is responsible for the fate of their own country" have become ubiquitous, and compliance with the government's anti-epidemic measures have been sublimated into patriotic acts to save the country. Therefore, driven by nationalistic ideology, people are more likely to embrace the newly developed vaccines. As the distinctive characteristic of China, the influence of nationalism on vaccine acceptance has not been explicitly discussed in the existing literature. Thus, we utilized data collected during the pandemic to examine how nationalism, along with the risk perception and altruism, has influenced public's attitudes towards the COVID-19 vaccines.

Literature and Hypotheses

Vaccines have been highly recognized by the medical community for increasing defenses against infectious diseases. However, vaccines are always confronted with skepticism and hardly ever trusted by all people [19,20]. Their effectiveness, safety, and even necessity have been long discussed by both the

public as well as experts in the field of public health [21-24]. People's concerns about or support for vaccines stem from both fear of personal health risks and regard for their community.

Effect of self-interest on public opinion of the vaccine

Individual risk perception, people's judgments about the possibility of infection and resulting consequences, can influence their opinions about vaccine safety and efficacy. Numerous studies have found relatively similar results regarding the impact of the perceived likelihood and perceived severity of infection on vaccine acceptance [25-27]. The first finding is that those who perceive themselves as less susceptible to infection are more likely to downplay the importance of the vaccine and thus to be less receptive to it. The second is that perceived severity is a significant factor in vaccine acceptance. People who have lower immunity or underlying health conditions are more likely to understand that COVID could be severe or even life-threatening for them. So, people with greater risk perception will be more inclined to take precautions against it and have more confidence in the vaccine's quality and effectiveness. Accordingly, we propose hypothesis 1: An individual's risk perception will enhance his or her acceptance of the COVID-19 vaccine.

The effect of altruistic motivation on public opinion of the vaccine

In addition to self-risk perception, people's concern for others is a significant factor that influences their attitudes about vaccines. Altruism is when we act to promote someone else's welfare, even at risk or cost to ourselves. In this case, it may manifest as getting a vaccination to protect others from infection, particularly those who are ineligible, such as pregnant women, the elderly, and children. Empirical research on recruiting subjects for HIV vaccine studies has shown altruism as the most important motivation to participate in these trials [28-30]. Surveys on willingness to vaccinate for covid-19 have also found a positive connection between altruism and the acceptance of vaccination [14,15,18].

A high level of social identity and awareness of social responsibility results in altruistic and pro-social behavior, such as willingness to receive the COVID-19 vaccine [16]. According to experimental studies during the epidemic, individuals who are motivated by compassion are more willing to get vaccinated [13]. Compared to mandatory vaccination policies, emphasizing the positive outcomes of an individual's altruistic behavior can strengthen his or her motivation to be vaccinated and reduce the costs of herd immunity [31]. Thus, we propose hypothesis 2: People who are strongly motivated by altruism will be more likely to have positive opinions about the vaccine.

The effect of national identity on public opinion of the vaccine

Nationalism is an ideology that is based on the premise that one's loyalty and devotion to the nation-state surpasses all other individual or group interests [32]. In the midst of a crisis, nationalism is often used as a political mobilization tool by the government to foster a sense of belonging, solidarity and patriotism through language, media, and education, thereby linking citizens' own interests and fate to that of the nation [33]. Since 1990s, the Chinese government has launched nationwide nationalistic propaganda as an ideological tool for political mobilization [34]. Over the years, this ideological propaganda has become a ubiquitous component of education, diplomatic occasions, international sporting events, artwork, entertainment, and even various advertisements by subtly promoting patriotic values [35-37]. It emphasizes the supremacy of the nation, meaning that people should love their country and place national interests above all else. Personal interests should be sacrificed for the good of the national, etc. In this way, nationalistic values such as obedience to the government and promotion of a national identity have become mainstream ideologies with which the Chinese people consciously identify. This is the major difference between China and democracies. This ideology has had a significant impact on people's values and behaviors and is a major source for the high level of trust the Chinese people place in their government [38].

When facing public crises, the Chinese government also utilizes collectivist and nationalist discourse to mobilize the public to resist external threats [39]. During the epidemic, the government invested many resources for promoting the vaccine. For example, officials instilled confidence about the safety and effectiveness of domestically produced vaccines through the popularization of expert scientists, the wide dissemination of officially sanctioned news, and grassroots cadres' persuasion. These elements also highlight the positive international influence of the domestic vaccine as well as the economic and social benefits of the country from vaccination, in the hopes of increasing public acceptance and willingness to be vaccinated. Chinese government officials at all levels have repeatedly stressed that vaccination is not only an act of personal protection but will also safeguard national interests. For example, in April 2021, the following quote was posted on the official website of People's Daily Online: "Vaccination is a powerful tool to overcome epidemics. It benefits oneself and others, as well as the country and the people, and it is not a multiple-choice but a must-answer question".

Cross-national comparative studies have shown that people living in political cultures that emphasize collectivistic values are more likely to take preventive health measures, such as using masks

frequently and adhering to quarantine policies, etc. [40]. Another study based on China also found that there is a strong correlation between nationalism and one's willingness to wear masks [41]. According to an empirical study of online public opinion in China, netizens were proud that their country was involved in vaccine development and were generally optimistic about the quality of the vaccines [42]. So, we propose hypothesis 3: Nationalism will increase public confidence in the quality of domestic COVID-19 vaccines.

Methods

Data source

The data for this study were obtained from a national survey conducted in early May 2021. At that time, although the epidemic in China was nearly under control, masking and social distancing were still advocated. Sampling and data collection, which were conducted by the Shanghai-based Diaoyanba Research Company, involved amassing a sample pool of regional (provincial) geographic locations, age cohorts, and gender distribution that matched the demographic data in the 2019 China Statistical Yearbook. All participants, who were required to fill out an anonymous questionnaire, were allowed to withdraw from the study at any time if they felt uncomfortable. Those who completed the questionnaire received a small monetary reward of 18 yuan (approximately $2.59). A research university in East China approved the data collection protocol.

Measures

Dependent variables

The dependent variables in this study are individuals' perceived safety and perceived effectiveness of vaccines, which are measured by the following survey statements, "I think the domestic vaccine is safe." and "I think the domestic vaccine is effective". The answers are rated on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Table 1 shows more detailed information of the variables.

Variables	Variable Definition	Mean/ Frequency	Standard Deviation/ Percentage
Dependent variables			
Perceived safety	Ordinal variable, 1-5	4.69	0.618
Perceived effectiveness	Ordinal variable, 1-5	4.629	0.662
Kay variables			
Perceived likelihood	Ordinal variable, 1-5	2.043	1.305
Perceived severity	Ordinal variable, 1-5	3.859	1.406
Donation	Ordinal variable, 1-5	2.662	0.847
Voluntary service	Ordinal variable, 1-5	2.6	1.025
National benefits	Ordinal variable, 1-5	3.924	0.846
Government Identification	Ordinal variable, 1-7	3.957	2.049
Scientists trust	Ordinal variable, 1-10	9.376	1.224
Control variables			
Usage of traditional media	Ordinal variable, 1-5	3.156	1.065
Usage of social media	Ordinal variable, 1-5	2.692	1.067
Vaccine literacy	Continuous variable,1-4	2.022	1.21
Age	**Ordinal categorical variable**		
	"18-29"=1;	443	21.74%
	"30-39"=2;	527	25.86%
	"40-49"=3;	542	26.59%
	"50-59"=4.	526	25.81%
Gender	**Dummy variable**		
	male=0;	1045	51.28%
	female=1	993	48.72%

Education	**Ordinal categorical variable**		
	Middle school and below=1;	253	12.41%
	High school=2;	356	17.47%
	Tertiary education=3;	692	33.95%
	College=4;	688	33.76%
	Graduate and above=5.	49	2.40%
Monthly income	**Ordinal categorical variable**		
	"3000 and below"=1;	511	25.07%
	"3001-5000"=2;	738	36.01%
	"5001-10000"=3;	623	30.57%
	"10001-20000"=4;	142	6.97%
	"20000 and above"=5.	24	1.18%

Table 1: Variable definitions and descriptive statistics.

Key variables

The key variables include self-interest, altruism and nationalism. The first, which manifests as one's concern about infection risk, was measured by the perceived likelihood and perceived severity of being infected. These factors were gauged by the following two statements: "I am likely to become infected by COVID-19." and "COVID-19 is a major threat to my health".

Altruism was measured by two variables, the first of which was the "frequency of donation", which was gauged by the question, "How often do you donate to charities and disaster areas?" The second was "frequency of volunteering," which was assessed by the question "How often do you participate in voluntary service?"

Nationalism was evaluated by two variables, the first of which was perception of national benefits, which was measured by the statement, "The widespread vaccination of COVID-19 would protect the country from the epidemic". The second was government identification, which was measured by the statement, "I would support our government even if it makes mistakes".

Control variables

According to many quantitative studies, demographic characteristics can influence opinions about vaccines. As individuals get older, they may become less resistant to infectious diseases and therefore be more dependent on vaccines [43]. In addition, socioeconomic status and gender can influence perceptions of health policy and thus in turn affect the importance individuals place on vaccines [44,45]. Accordingly, the control variables in this study focused on demographic characteristics such as age, gender, education, and monthly income of the respondents.

In addition, individuals' vaccine literacy and access to health information also influence their attitudes toward vaccines [46,47]. In this study, these two factors were controlled in the model. The first was measured by respondent's responses to the following four vaccine-related statements: "Smallpox will not be eliminated without widespread use of vaccines"; "Children's immune systems will not develop properly if they receive many vaccines too early"; "Vaccination does not increase the occurrence of allergies"; and "If children are not given as many vaccines, they will be more resistant to diseases". A score of 1 was awarded if the respondent answered correctly, and a high cumulative score indicates a high level of vaccine literacy. The second was information exposure, which was measured by the usage of traditional media and social media.

Statistical model

The dependent variables in this study, perceived safety and perceived effectiveness of the vaccine in China, were measured by using a 5-point Likert scale. Since the dependent variables are both 5-level ordinal variables, we adopted ordered logit models in this study. Then, to compare the effects of the three groups of variables, we compute the marginal effects of key variables and calculate their relative contributions by Shapley decomposition.

Results

According to our findings, the Chinese people are very confident about the safety and effectiveness of domestic COVID-19 vaccines (M_{safety}= 4.690, SD_{safety}=0.618; $M_{effectiveness}$=4.629, $SD_{effectiveness}$=0.662), as over 70 percent of respondents identified them as either quite safe or very effective. The regression results are displayed in (Tables 2 and 3).

	Perceived safety of COVID-19 vaccine		
	Model 1	**Model 2**	**Model 3**
Key variables			
Perceived likelihood	-0.095*	-0.113**	-0.117*
	(-2.24)	(-2.62)	(-2.58)
Perceived severity	0.208***	0.219***	0.179***
	(5.43)	(5.65)	(4.51)
Donation		0.202**	0.164*
		(2.75)	(2.21)
Voluntary Service		0.11⁹*	0.132*
		(1.98)	(2.15)
National Benefits			0.515***
			(8.07)
Government Identification			0.120***
			(4.32)
Control variables			
Vaccine literacy	0.223***	0.215**	0.178**
	(5.14)	(4.92)	(3.78)
Traditional media	0.053	0.025	-0.011
	(0.95)	(0.45)	(-0.18)
Social media	0.093+	0.052	0.031
	(1.75)	(0.96)	(0.56)
Age	0.049	0.046	0.028
	(0.91)	(0.84)	(0.51)
Gender	-0.302**	-0.262**	-0.197+
	(-2.86)	(-2.47)	(-1.82)
Education degree	0.066	0.029	0.042
	(1.20)	(0.50)	(0.73)
Income	0.072	0.061	0.029
	(1.10)	(0.92)	(0.43)
Log likelihood	-1411.7083	-1402.5149	-1359.6095
LR chi2	86.32	104.70	190.51
Pseudo R^2 (McFadden's R^2)	0.0297	0.0360	0.0655
N	2038	2038	2038
t statistics are in parentheses; *$p<0.05$, **$p<0.01$, ***$p<0.001$			

Table 2: Regression results of factors influencing perceptions of vaccine safety.

	Perceived effectiveness of COVID-19 vaccine		
	Model 4	Model 5	Model 6
Key variables			
Perceived likelihood	-0.085*	-0.101*	-0.113**
	(-2.12)	(-2.49)	(-2.64)
Perceived severity	0.197***	0.205***	0.169***
	(5.41)	(5.59)	(4.50)
Donation		0.222**	0.192**
		(3.20)	(2.73)

Voluntary service		0.088	0.095
		(1.54)	(1.63)
National benefits			0.470***
			(7.66)
government identification			0.132***
			(5.02)
Control variables			
Vaccine literacy	0.240***	0.233***	0.190***
	(5.26)	(5.59)	(4.51)
Traditional media	0.058	0.029	-0.002
	(1.09)	(0.55)	(-0.03)
Social media	0.069	0.032	0.008
	(1.38)	(0.62)	(0.16)
Age	-0.001	-0.003	-0.022
	(-0.02)	(-0.06)	(-0.42)
Gender	-0.369**	-0.331***	-0.267**
	(-3.70)	(-3.30)	(-2.60)
Education degree	0.002	-0.033	-0.022
	(0.004)	(-0.61)	(-0.40)
Income	0.070	0.058	0.025
	(1.13)	(0.94)	(0.39)
Log likelihood	-1574.4572	-1564.8093	-1521.4478
LR chi2	92.90	112.20	198.92
Pseudo R^2 (McFadden's R^2)	0.0287	0.0346	0.0614
N	2038	2038	2038
t statistics are in parentheses; $^{+}p<0.1$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$			

Table 3: Regression results of factors influencing perceptions of vaccine effectiveness.

Regression results

First, we examined the influence of perceived likelihood and perceived severity on the perception of vaccine safety and effectiveness (Table 2 model 1 and Table 3 model 4). The pseudo R-square (McFadden's R-square, the same below) shows that the goodness-of-fit of models 1 and 4 are 0.0297 and 0.0287, respectively. The coefficients of perceived likelihood are both negative in two models, with weak significances (β_{safety}=-0.095, t =-2.24, P=0.025; $\beta_{effectiveness}$=-0.085, t=-2.12, P=0.034). This indicates that the perceived likelihood of infection leads to a negative influence on vaccine quality. In terms of perceived severity, respondents' who believe that contracting Covid-19 would be a severe threat to their health were more likely to think highly of the safety and effectiveness of the vaccines (β_{safety}=0.208, t=5.43, P<0.000; $\beta_{effectiveness}$=0.197, t=5.41, P<0.000). The regression results indicate that high personal risk perception is not necessarily associated with positive opinions of the vaccine quality.

To test hypothesis 2, we added the altruism variables in models 2 and 5. Correspondingly, the pseudo R-square increases to 0.0360 and 0.0346, indicating that the introduction of these variables improves the goodness-of-fit of the models. Also, frequency of donation has a significant positive effect on the perception of vaccine safety and effectiveness (β_{safety}=0.202, t=2.75, P<0.01; $\beta_{effectiveness}$=0.222, t=3.20, P<0.01). With regard to frequency of volunteering, it also has a positive effect on their opinions about vaccine quality, while its significances are not stable (β_{safety}=0.119, t=1.98, P=0.05; $\beta_{effectiveness}$=0.088, t=1.54, P=0.124). The statistical results suggest that respondents with stronger altruistic values tend to be more optimistic about vaccine quality and the hypothesis 2 has been verified in general.

To test hypothesis 3, we incorporated the participants' nationalism into model 3 (Table 2) and model 6 (Table 3). The pseudo R-square of the two models were 0.0655 and 0.0614, respectively, higher than that of models 2 and 5, indicating that the addition of nationalistic factors promotes the goodness-of-fit of previous models. The statistical results show that respondents'

perception of national benefits has significantly positive impact on their perceptions of vaccine safety and effectiveness (β_{safety}=0.515, T =8.07, P<0.000; $\beta_{effectiveness}$=0. 0.470, t=7.66, P<0.000). In addition, respondents' government identification also has positive effect on their perceptions of vaccine safety and effectiveness (β_{safety}=0.120 T =4.32, P<0.000; $\beta_{effectiveness}$=0. 0.132, t=5.02, P<0.000). Thus, hypothesis 3 has been demonstrated, which indicates that nationalism is an important driver of vaccine acceptance.

With respect to the control variables, those who have a better knowledge of vaccines were significantly more likely to accept them, and male respondents were more likely to have a greater appreciation for them than the female participants. Moreover, media use, age, gender, education level, and income had no significant impact on perception of vaccine quality.

Marginal effect

To further understand the effects of various factors on vaccine acceptance, we calculated the marginal effects of the key variables separately, holding all other variables at their means (base on model 3 and model 6).

The marginal effects show that when the perceived likelihood of infection increases by one level, the probability of respondents' selection of "strongly agree" will decline by 1.96 % and 2.10% respectively. Meanwhile, the probability that respondents will select "somewhat agree", "neither agree nor disagree", "somewhat disagree" or "strongly disagree" will increase by 1.40%, 0.44%, 0.7%, 0.05% (Table 4) and 1.39%, 0.58%, 0.08%, and 0.04% (Table 5), respectively. In terms of perceived severity, when respondents' perception of the health threat increases by one level, the probability that they will strongly agree that vaccines are safe and effectiveness will increase by 3.01% and 3.16% respectively. Correspondingly, the probability that they will select "somewhat agree", "neither agree nor disagree", "somewhat disagree" or "strongly disagree" will decrease by 2.14%, 0.68%, 0.11%, 0.07% (Table 4) and 2.09%, 0.87%, 0.12%, and 0.07% (Table 5) respectively.

In terms of altruism, the marginal effect shows that when the "frequency of donation" increases by one level, the probability of participants' selection of "strongly agree" on the safety and effectiveness will increase by 2.75% and 3.57% respectively. The probability of respondents' selection of "somewhat agree", "neither agree nor disagree", "somewhat disagree" or "strongly disagree" will decrease by 1.96%, 0.62%, 0.10%, and 0.07% (Table 4), and 2.37%, 0.99%, 0.14% and 0.8% (Table 5). Likewise, when respondents' "frequency of volunteering" increases by one level, the probability that they strongly agree on the safety and effectiveness of vaccines will increase by 2.22% and 1.77% respectively. The probability of respondents' selection of "somewhat agree", "neither agree nor disagree", "somewhat disagree" or "strongly disagree" will decline by1.58%, 0.50%, 0.08%, and 0.05%, and 1.17%, 0.49%, 0.07%, and 0.04%. The results of the marginal effect showed that individuals with higher altruistic tendencies were more likely to accept the domestic vaccines.

The marginal effect of nationalism showed that when awareness of national benefits increases by one level, the probability that respondents strongly agree that vaccines are safe and effective will rise by 8.65% and 8.76% on average. The probability that respondents will choose "somewhat agree," "neither agree or disagree," "somewhat disagree," and "strongly disagree" will decrease by 6.16%, 1.96%, 0.33%, 0.20% Table 4), and 5.81%, 2.42%, 0.34% and 0.19% (Table 5). For each level of increase in respondents' government obedience, the probability of selecting "strongly agree" will increase by 2.02% and 2.46% on average. The probability that they believe vaccines are somewhat safe, neither safe nor unsafe, somewhat unsafe and very unsafe will correspondingly drop by 1.43%, 0.46%, 0.08% and 0.05%. Similarly, the probability that respondents will believe that vaccines are somewhat effective, neither effective nor ineffective, somewhat ineffective and completely ineffective will diminish by 1.63%, 0.68%, 0.10%, and 0.05%, respectively. Comparing the marginal effects of the three group variables, it can be found that nationalism had the greatest effect on individuals' perceived safety and effectiveness of vaccines.

	Perceived possibility	**Perceived severity**	**Donation**	**Voluntary service**	**National benefits**	**Government identification**
Strongly disagree	0.0005^{+}	-0.0007*	-0.0007^{+}	-0.0005^{+}	-0.0020**	-0.0005*
	(0.0002)	(0.0003)	(0.0004)	(0.0003)	(0.0008)	(0.0002)
Somewhat disagree	0.0007*	-0.0011**	-0.0010^{+}	-0.0008^{+}	-0.0033**	-0.0008**
	(0.0003)	(0.0004)	(0.0006)	(0.0005)	(0.0010)	(0.0003)
Neither agree or disagree	0.0044*	-0.0068***	-0.0062*	-0.0050*	-0.0196***	-0.0046***
	(0.0018)	(0.0017)	(0.0029)	(0.0024)	(0.0031)	(0.0012)
Somewhat agree	0.0140*	-0.0214***	-0.0196*	-0.0158*	-0.0616***	-0.0143***
	(0.0054)	(0.0047)	(0.0088)	(0.0073)	(0.0073)	(0.0033)
Strongly agree	-0.0196*	0.0301***	0.0275*	0.0222*	0.0865***	0.0202***
	(0.0076)	(0.0066)	(0.0124)	(0.0103)	(0.0102)	(0.0046)
Standard errors are in parentheses; $^{+}p<0.1$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$						

Table 4: The marginal effects of perceived safety of vaccines.

	Perceived possibility	Perceived severity	Donation	Voluntary service	National benefits	Government identification
Strongly disagree	0.0004^{+}	-0.0007*	-0.0008*	-0.0004	-0.0019**	-0.0005*
	(0.0002)	(0.0003)	(0.0004)	(0.0003)	(0.0005)	(0.0002)
Somewhat disagree	0.0008*	-0.0012**	-0.0014*	-0.0007	-0.0034**	-0.0010**
	(0.0004)	(0.0004)	(0.0006)	(0.0005)	(0.0010)	(0.0003)
Neither agree or disagree	0.0058*	-0.0087***	-0.0099**	-0.0049	-0.0242***	-0.0068***
	(0.0023)	(0.0021)	(0.0037)	(0.0030)	(0.0037)	(0.0015)
Somewhat agree	0.0139**	-0.0209***	-0.0237**	-0.0117	-0.0581***	-0.0163***
	(0.0053)	(0.0046)	(0.0086)	(0.0072)	(0.0073)	(0.0032)
Strongly agree	-0.0210**	0.0316***	0.0357**	0.0177	0.0876***	0.0246***
	(0.0079)	(0.0069)	(0.0130)	(0.0108)	(0.0109)	(0.0048)
Standard errors are in parentheses; $^{+}p<0.1$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$						

Table 5: The marginal effects of perceived effectiveness of vaccines.

The contribution of explanatory variables

To further compare the influence of the three explanations, we try to calculate the relative contribution of explanatory variables by adopting Shapley decomposition [48]. The results are displayed in (Table 6).

As the Shapley value shows in (Table 6), the relative contribution of risk perception hypothesis and altruism hypothesis respectively account for 14.20% and 11.42% of the perceived safety of vaccines, 13.84% and 10.97% of their perceived effectiveness. While the nationalistic variables account for 54.88% of the perceived safety, and 53.21% of the perceived effectiveness, which account for the largest share of the contribution. This suggests that the nationalistic values have played a dominating role in inspiring people's acceptance of COVID-19 vaccines in China during the epidemic.

Factors	Perceived safety		Perceived effectiveness	
	Shapley value	Per cent	Shapley value	Per cent
Risk perception	0.0093	14.20%	0.0085	13.84%
Altruism	0.0075	11.42%	0.0067	10.97%
Nationalism	0.0359	54.88%	0.0326	53.21%
Control variables	0.0128	19.50%	0.0135	21.98%
Total	0.0655	100%	0.0614	100%

Table 6: Shapley decomposition of Model 3 and Model 6.

Discussion

Why have Chinese people readily accepted domestic vaccines?

Many researches have explored the influence of trust in experts on confidence in vaccines [49-52]. When confronting unknown health threats, medical experts are expected to participate in policy-making and implementation of epidemic prevention. Not only do people need to learn how to protect themselves from experts, the government needs professional advice on creating epidemic prevention policies and developing new vaccines. Some social surveys manifest that public trust in medical experts remained at a relatively high level during the epidemic [53]. And the survey we adopted also shows that nearly 85% of respondents fairly trust Chinese scientists. So, we deduce that trust in scientists is also a factor that need to be considered when discussing the public's attitudes toward vaccines.

We further examined the impact of trust in Chinese scientists on vaccine acceptance. After adding "trust in scientists" into the models, the values of pseudo R-square of models 7 and 8 reached 0.1682 and 0.1685 (see Table 7), which indicates that the goodness-of-fit of new models were significantly improved when compared with previous models (Model 3 and Model 6). Regression results show that the public's trust in scientists helps to build their confidence in the vaccines (β_{safety}=0.772, t=16.37, P<0.000; $\beta_{efficiency}$=0.815, t=17.44, P<0.000) (see Table 7). In terms of the results of Shapley decomposition, the Shapley value of trust in scientists indicates that its relative contribution exceeds 70% in both Model7 and Model8 (see Table 8), relatively higher than other variables, which means that trust in scientists is an important influencing factor to be reckoned with when discussing the acceptance of the COVID-19 vaccines.

	Perceived safety	Perceived effectiveness
	Model 7	Model 8
Key variables		
Perceived likelihood	-0.046	-0.039
	(-0.94)	(-0.86)
Perceived severity	0.116**	0.102*
	(2.73)	(2.52)
Volunteer service	0.128*	0.088
	(1.99)	(1.45)
Donation	0.189+	0.188*

	(1.79)	(2.54)
National benefits	0.305**	0.259***
	(4.40)	(3.91)
government identification	0.085**	0.096**
	(2.86)	(3.43)
Scientists trust	0.772***	0.815***
	(16.37)	(17.44)
Control variables		
Vaccine literacy	0.110*	0.131**
	(2.34)	(2.94)
Public media	-0.053	-0.053
	(-0.87)	(-0.92)
Social media	0.007	0.001
	(0.11)	(0.01)
Age	0.021	-0.026
	(0.35)	(-0.47)
Gender	-0.191+	-0.289**
	(-1.67)	(-2.69)
Education degree	0.058	-0.004
	(0.96)	(-0.07)
Income	0.051	0.056
	(0.73)	(0.85)
Log likelihood	-1210.1187	-1347.836
LR chi2	489.50	546.15
Pseudo R^2 (McFadden's R^2)	0.1682	0.1685
N	2038	2038
t statistics are in parentheses; $^{+}p<0.1$, $^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$		

Table 7: The influencing of trust in scientists on the perceived quality of vaccines.

Factors	Perceived safety		Perceived effectiveness	
	Shapley value	Per cent	Shapley value	Per cent
Risk perception	0.0064	3.79%	0.0057	3.37%
Altruism	0.0065	3.87%	0.0061	3.61%
Nationalism	0.0246	14.59%	0.0223	13.20%
Trust in scientists	0.1206	71.71%	0.1233	73.21%
Control variables	0.0102	6.04%	0.0111	6.60%
Total	0.1682	100%	0.1685	100%

Table 8: Shapley decomposition of Model 7 and Model 8.

In China, it is possible that the status and authority of scientists are intentionally shaped by the government. Generally, the public knows little about them, since their daily work and achievements are rarely reported. However, all of this changed during the epidemic. After the outbreak in Wuhan, the government enlisted several scientists to be opinion leaders to stand for the epidemic prevention policies and persuade the public. In the end of January 2020, a national medical team of experts was established to guide epidemic control. Most members of the team were not publicly known; however, Zhong Nanshan and Li Lanjuan quickly became famous as the spokespeople of the team. In the following months, as they advised the terrified public via authoritative media, they were even seen as an example of numen. The public's concerns about the necessity and efficacy of the "lockdown" policy and the safety and effectiveness of vaccines, were often addressed by scientists. The government also held a grand ceremony to award the scientists with the highest national honors including "The medal of the Republic" and "People's Hero" to publicize their great contributions. These experts have different public personas. For example, Nanshan Zhong, an academician at the Chinese Academy of Engineering, comes across as experienced, responsible and sensible; Dr. Zhang Wenhong is humorous and friendly; and Li Lanjuan and Chen Wei are the elegant and intelligent female scientists. They can meet various groups' expectations and preference of authorities.

It can be inferred that the great deal of confidence the public places in these scientists is a result of government propaganda. To examine the relationship between scientist trust and nationalistic values, we employed the Person test to determine the correlation between trust in scientists and the "awareness of national benefits" and "government obedience" separately. The coefficients were 0.267 and 0.105 respectively and were both significant at a statistical level of 1‰. This indicates that strong nationalism is associated with high trust in scientists. Thus, trust in scientists may derive from nationalistic values and government propaganda.

According to the regression results, shown in (Tables 2 and 3), perceived likelihood of infection has a negative impact on confidence in the vaccines, that is, respondents who think they are more likely to be infected have less confidence in the vaccines, which is contrary to previous findings. One possible explanation is that this scenario is also related to nationalism. The survey used in this article was completed in May of 2021, when the epidemic was effectively under control in China. Unlike the "Coexisting with COVID-19" strategy in other countries, the Chinese government has invested significant resources in controlling its spread, insisting on "dynamic zeroing" at all costs. Within a month before the survey conducted, newly confirmed COVID-19 cases in China dropped to less than 100 per day, and it has the lowest death cases compared to other major countries. Therefore, people generally believe that China is relatively safe, and the likelihood of individual infection is extremely low. Our data shows that the mean value of all respondents' perceived likelihood is 2.043, far lower than the perceived severity of 3.859 (scaled from 1 to 5). People who have confidence in governmental policies are less concerned about being infected. Otherwise, those with a higher perceived likelihood of infection have less confidence in the government, and thus are skeptical about the quality of vaccines. This finding suggests that perceived likelihood is also influenced by nationalism.

Conclusion

People's assessment of the domestic vaccines is quite positive and optimistic in China. The basic findings of this paper are that nationalism is the key driving force about the vaccine acceptance. In addition, risk perception and altruism were found to partially influence individuals' attitudes toward vaccines.

Unlike Western democratic governments, strong nationalist ideology is a mainstream value of Chinese society and the result of the government's long-term ideological propaganda and patriotic education [54]. Nationalistic ideology is the source of political legitimacy and government trust in China [55-57]. Driven by nationalistic values, especially the highly appraised individual sacrifice for national interests, the Chinese government was able to implement stringent lockdown policies while simultaneously enjoying support from the public [58-60,41]. In this way, nationalistic values have also affected the public's ready acceptance of vaccines. Since the Chinese government does not directly disclose data on the safety and effectiveness of vaccines, there should be no sufficient empirical evidence for public's confidence in vaccines. Therefore, the high trust in vaccines may have less to do with actual vaccine quality than ideological construction. This is a key mechanism for understanding epidemic prevention and control in China.

It must be noted that our survey was completed in May 2021 and does not cover subsequent changes. When Omicron broke out in Shanghai in the spring of 2022, the government has been insisting on the "dynamic zero-COVID" policy, which led to a stringent lockdown for more than two months and aroused continuous public complaints. As the epidemic continues, we need more surveys to examine people's perceptions of vaccine quality and their attitudes towards the epidemic prevention policies.

Declarations

Ethics approval and consent to participate

The survey was approved by Zhejiang University.

Consent for publication

Not applicable.

Availability of Data and Materials

The raw data supporting the conclusions of this article will be made available by the corresponding author, without undue reservation.

Competing Interests

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Authors' Contributions

YY: literature review and hypotheses, data analysis, first draft of the manuscript.

QZ: literature review, methodology, and writing.

ZS: conceptualization, data collection, discussion and revision.

GZ: conceptualization, discussion, writing and editing.

All authors contributed to the study conception, research design, and work together to revise our manuscript repeatedly.

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