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Table of Contents

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Abstract

Background: As cold-chain transportation in frozen food may lead to localized outbreaks of COVID-19 in destinations. Given the high level of exposure to SARS-CoV-2, the cold-chain food workers are considered priority vaccination groups. To date, a number of studies have reported the willingness to be vaccinated against COVID-19 within distinct populations, whereas it has not been reported among cold-chain food workers worldwide.

Objective: We aim to investigate the willingness for COVID-19 vaccination and its influencing factors within cold-chain food workers during the COVID-19 pandemic.

Methods: An online cross-sectional, population-based survey was employed to gather information regarding the willingness of COVID-19 vaccination and the knowledge, attitudes, and practices (KAP) associated with COVID-19 and vaccination among cold-chain food workers in Shenzhen City of China. Binomial logistic analyses were conducted to qualify the associations between COVID-19-related KAP factors and the willingness of COVID-19 vaccination using adjusted odds ratios (aORs) and 95% confidence interval (CI).

Results: A total of 244 cold-chain food workers were recruited. Overall, 76.2% of the subjects indicated that they were willing to be vaccinated. After adjustment for general characteristics, knowledge on COVID-19 conception (aOR 2.313, 95%CI 1.098-4.872), comprehending the most effective measure (aOR 2.399, 95%CI 1.233-4.666), understanding the transmission routes (aOR 8.760, 95%CI 2.406-31.890), and recognizing the priority vaccination groups (aOR 2.587, 95%CI 1.331-5.029) were positively associated with the dependent variable. Regarding attitude factors, perceiving the social harmfulness (aOR 2.643, 95%CI 1.178-5.927) and severity of COVID-19 (aOR 3.109, 95%CI 1.116-8.660) were related to a higher willingness to get vaccinated. In terms of practice factors, participants who have attained more knowledge (aOR 2.608, 95%CI 1.115-6.099) were more likely to be vaccinated, and higher self-reported compliance with maintaining indoor ventilation (aOR 2.371, 95%CI 1.049-5.363) was also positively associated with the dependent variable. Agreement on the importance of vaccination to prevent COVID-19 was the most frequent reason for accepting the COVID-19 vaccine; additionally, concerns about side effects and poor understanding of efficacy were the main factors contributing to the vaccination refusal.

Conclusions: Enhancing KAP levels related to COVID-19 might be the key to promote vaccine acceptance. Health authorities ought to promptly implement educational activities following the updated vaccine situations.

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Abstract

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Agreement on the importance of vaccination to prevent COVID-19 was the most frequent reason for accepting the COVID-19 vaccine; additionally, concerns about side effects and poor understanding of efficacy were the main factors contributing to the vaccination refusal.

Conclusion: Enhancing KAP levels related to COVID-19 might be the key to promote vaccine acceptance. Health authorities ought to promptly implement educational activities following the updated vaccine situations.

Keywords: COVID-19; Vaccine; Willingness; Cold-chain food workers; Acceptance; Knowledge; Attitudes; Practices

Introduction

The epidemic of Coronavirus disease 2019 (COVID-19) has been disseminating worldwide since December 2019 [1], and more than 119.2 million confirmed cases of COVID-19 were reported according to the World Health Organization (WHO) [2]. Despite the fact that preventive measures have effectively curbed the spread of the outbreak, including movement restrictions, travel bans, quarantine, wearing face masks, hand washing, and social distancing [3], the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is continuing to increase and threaten public health across the globe.

As immunization is one of the most potent weapons against infectious diseases, efficacious vaccination is expected to finalize the COVID-19 pandemic in the future [4]. At present, significant progress has been made globally for the development of the COVID-19 vaccine, producing hundreds of vaccine candidates ranged from traditional inactivated vaccines and recombinant DNA vaccines and mRNA vaccines utilizing various technologies [4-6]. As of 31 March 2021, approximately 82 vaccines are currently being tested through clinical trials on humans, and 23 have measured up the final stages of evaluation [7]. In China, the cost-free vaccination for COVID-19 had been used for the first time among high-risk groups such as healthcare workers and epidemic prevention personnel since 22 July 2020. Subsequently, the COVID-19 vaccine is scheduled for the general Chinese population, and more than 100 million doses of vaccine have been received by 31 March 2021 [8].

As a novel emerging infectious disease, understanding the public's concerns regarding the pandemic vaccines is vital since vaccine acceptance reflects the overall disease risk and vaccine demand among the general public, which is essential to achieve sufficient pandemic vaccines [9, 10]. For example, previous studies focused on the acceptance and usage of the vaccine against the 2009 H1N1 pandemic showed the willingness to accept 2009 H1N1 pandemic vaccination was 67.0% in the Australian public [11], while only 17.0% among healthcare workers in Greece [12]. A systematic review indicated the COVID-19 vaccine acceptance rates in 33 different countries

were ranged from 23.6% to 97.0% among adults representing the general population [13]. Consequently, reports on acceptance of the COVID-19 vaccine are warranted to clarify in each country or region and various populations.

It is commonly recognized that better knowledge, attitudes, and practices (KAP) among the public are critical to guarantee the final success of the battle against pandemics [14, 15]. Heightening the public's consciousness about the seriousness of the disease is of benefit to advance their willingness to be vaccinated [16]. Our previous study indicated participants who knew better about pneumonia were more willing to receive the pneumococcal vaccine than those who failed to understand [17]. Likewise, prior research illustrated that the perceived risk of COVID-19 was a significant predictor of vaccination intention among 1144 middle eastern participants [16]. Numerous studies, by far, have been published focused on COVID-19-related KAP and the willingness to be vaccinated within different populations worldwide [15, 18, 19], especially for high-risk groups such as healthcare workers [20-22].

After the COVID-19 pandemic, China quickly responded and took sufficient measures for containing the spread across the country, while sporadic and localized outbreaks still occurred. On 4 September 2020, two Chinese stevedores were reported SARS-CoV-2 positive during the routine nucleotide acid test, and an epidemiological investigation was then carried out to identify the source of infection. The results showed that 50 out of 421 surface samples of the frozen cod outer package were tested positive for SARS-CoV-2 [23]. Even though the likelihood of transmission on frozen food is considered lower than other transmission routes, scientists believed SARS-CoV-2 could be transmitted on frozen surfaces [24, 25]. Hence, a number of localized COVID-19 outbreaks in different cities in China could be tracked to originate from workers at cold port storage, seafood processing facilities, and market sites associated with imported cold-chain food [26-28], providing accumulating evidence that these persons who work in the cold, high humidity, and congregate locations are also at high risk for both the acquisition and transmission of respiratory infections and should be considered as the priory vaccination population [25].

However, to the best of our knowledge, there is currently no relevant study on accepting COVID-19 vaccination in workers who have frequent contact with imported cold-chain food, such as dockworkers and stevedores (we called cold-chain food workers for this study).

In the present study, we conducted a cross-sectional investigation to survey the willingness towards COVID-19 vaccination and its influencing factors among cold-chain food workers in China during the COVID-19 pandemic. Specifically, the purposes of our study included: (1) describing the levels of COVID-19-related knowledge, attitudes, and practices according to the willingness to accept COVID-19 vaccine among cold-chain food workers, (2) investigating the associations between COVID-19-related KAP and willingness to be vaccinated, (3) identifying the reasons for acceptance or not of COVID-19 vaccination in an attempt to facilitate health education and management.

Methods

Study Design, Participants, and Sampling

This cross-sectional investigation was conducted in Shenzhen City between 16 December 2020 and 21 December 2020, with over 13 million local populations in southern China as of 2018 [29]. Data were collected through an approved questionnaire from the Longhua Center for Disease Control and Prevention (CDC) of Shenzhen. The present study was developed via the most extensive online survey platform in China called Wen Juan Xing (Changsha Ranxing Information Technology Co., Ltd., Hunan, China). The Wen Juan Xing would check the completeness of questionnaires before submission, and thereby only the completed ones would be submitted successfully.

Regarding the targeted population, there are approximately six hundred employees in Longhua, an urban district of Shenzhen. Sample size calculation formula for cross-sectional surveys was utilized to determine the minimum theoretical sample size for the present study. For this survey, the acceptance rate was estimated to be 45% based

on the findings of a systematic review [13], the maximum allowable error was 0.15, and the level of statistical significance (α) was 0.05. Consequently, 218 participants were the minimum sample size. Employees were randomly selected, and only those who gave consent to be a part of the present survey would be recruited as participants. Finally, a total of 244 employees were involved with the complete information. The respondents were under quality control, and none of them were rolled out due to invalid questionnaires. The protocol for this research was approved by the Ethics Committee of Longhua CDC, Shenzhen.

Questionnaire

A self-administered questionnaire was developed for this investigation, and the validity of the questionnaire was assessed by experts in epidemiology and infectious diseases. We conducted a pre-test to generate the Cronbach's alpha coefficients to ensure reliability, indicating a 0.702 score for the knowledge section and 0.725 and 0.687 for the attitudes and practices sections, respectively. After that, the questionnaire was modified and finalized.

The contents of this survey questionnaire consisted of four parts covering baseline information, COVID-19-related KAP, and the willingness of COVID-19 vaccine usage. The general characteristics were presented in Part I, including gender (male, female), age (18-30, 31-40, and >40 years), education level (high school or lower, college or above), marital status (unmarried, married, and divorced), monthly income (<10,000, 10,000-30,000 and >30,000 CNY), and underlying diseases (yes, no). Part Ⅱ belonged to the knowledge section, designing based on the guideline for diagnosis and treatment of COVID-19 published by the National Health Commission of the People's Republic of China on 18 August 2020 [30], together with the national guideline for prevention and control of COVID-19 published on 11 September 2020 [31]. Part III collected information on participants' attitudes towards COVID-19 and the reasons for their willingness or not to be vaccinated against COVID-19. Part IV focused on participants' behaviors during the COVID-19 pandemic. All questions were closed-ended and treated as categorical variables.

Statistical analyses

The primary outcome of the present study was the acceptance of the COVID-19 vaccination. Participants who answered "yes" to the question "Are you willing to receive the COVID-19 vaccine?" were assigned to the willingness group, while those who answered "no" were classified into the unwillingness group.

Descriptive statistics were performed for the subjects' general characteristics and their knowledge, attitudes, and practices related to COVID-19 and vaccination. The categorical variables were presented as frequencies with percentages and 95% confidence intervals (CI) and were compared with chi-squared tests or Fisher's exact tests as appropriate between participants in these two groups. Binomial logistic regression models were conducted to investigate the associations between KAP factors and the willingness of COVID-19 vaccination after full adjustment for demographic variables, with adjusted odds ratios (aOR) and 95% CI being calculated. All analyses were generated in R statistical software v.4.0.3 (R Foundation for Statistical Computing, Vienna, Austria). We considered statistical tests with $P < .05$ statistically significant.

Results

General characteristics of the subjects

In total, 244 participants with complete data were involved in the present study. The descriptive characteristics and their willingness to receive the COVID-19 vaccine are shown in Table 1. A large proportion of subjects (76.2%) displayed willingness toward the COVID-19 vaccination. Among our participants, the proportion of men and women was 57.0 : 43.0 in this study, and roughly half of them (49.2%) were aged between 31 and 40 years. Most participants (84.8%) had an education level of high school or lower, whereas the group with a college or above education accounted for only 15.2% of subjects. The majority of the participants were unmarried (78.7%) and had a monthly income of CHN < 10,000 (83.6%). Merely 2.9% reported presenting an underlying disease. Also, all participants have not been diagnosed with COVID-19 in

the past year.

Table 1. General characteristics of subjects and willingness of COVID-19 vaccination, Shenzhen, China, December 2020

General characteristics	Total (n=244)		
	n	%	95% CI
Gender			
Male	139	57.0	50.5-63.3
Female	105	43.0	36.7-49.5
Age group (y)			
18-30	44	18.0	13.4-23.4
31-40	120	49.2	42.7-55.6
> 40	80	32.8	26.9-39.1
Education level			
High school or lower	207	84.8	79.7-89.1
College or above	30	15.2	8.5-17.1
Marital status			
Unmarried	43	17.6	13.1-23.0
Married	192	78.7	73.0-83.7
Divorced	6	3.7	0.9-5.3
Monthly income			
<10,000 CHY	204	83.6	78.4-88.0
10,000-30,000 CHY	25	10.2	6.7-14.8
>30,000 CNY	15	6.1	3.5-9.9
Underlying disease [a]			
No	58	97.1	94.2-98.8
Yes	186	2.9	1.2-5.8
Willingness of COVID-19 vaccination			
No	58	23.8	18.6-29.6
Yes	186	76.2	70.4-81.4

[a] Underlying disease included hypertension, heart diseases, diabetes, respiratory disease, and gastrointestinal disease.

Knowledge, Attitudes, and Practices towards COVID-19 and Vaccination

The description of knowledge, attitudes, and practices related to COVID-19 and its vaccine among participants is shown in Table 2-4. Regarding knowledge, numerous participants (82.0%) believed that the COVID-19 is a respiratory disease caused by

SARS-CoV-2 (*P* = .03). Of the subjects, 66.0% agreed that the COVID-19 vaccination is the most effective measure to prevent COVID-19 infection (*P* = .009), and a large number of them (94.7%) agreed that COVID-19 infection could be transmitted through respiratory droplets, aerosol, and contact with infected individuals (*P* < .001). During the survey, 73.8% of the subjects believed that the priority vaccination populations include healthcare workers, older adults, travelers from overseas, suspected cases of COVID-19, and people who had directly contacted COVID-19 patients (*P* = .003). Meanwhile, 83.6% of participants also considered the elderly or people with underlying diseases or weakened immunity as the vulnerable group (*P* = .07) (Table 2).

For participants' attitudes, most subjects (86.9%) agreed that the social harmfulness of COVID-19 is far greater than influenza, even if it would be a normalized infectious disease (*P* = .02), and 92.6% agreed that severe health and economic burdens could be attributed to COVID-19 infection (*P* = .06) (Table 3).

In terms of COVID-19-related practices, most participants (87.3%) agreed that they obtained more understanding of infectious disease prevention and control during this outbreak (*P* = .01). Among the participants, most of them preferred to prevent COVID-19 infection by wearing a mask outside (97.1%, *P* = .67), followed by washing hands frequently (95.1%, *P* = .65), maintaining indoor ventilation (86.9%, *P* = .02), avoiding crowded areas (85.2%, *P* = .06), and doing more exercises (69.7%, *P* = .27) (Table 4).

Table 2. Knowledge factors associated with the willingness to receive a COVID-19 vaccine among cold-chain food workers in Shenzhen, China, December 2020

Question	N (%)	Willingness of COVID-19 vaccination		OR (95% CI)	*P* value
		Yes	No		
The COVID-19 is a respiratory infectious disease caused by SARS-CoV-2.					
Yes	200 (82.0%)	158 (84.9%)	42 (72.4%)	2.313 (1.098-4.872)	.03
No or unsure	44 (18.0%)	28 (15.1%)	16 (27.6%)	1.000	
COVID-19 vaccination is the most effective measure to prevent the COVID-19 infection.					
Yes	161 (66.0%)	131 (70.4%)	30 (51.7%)	2.399 (1.233-4.666)	.01
No or unsure	83 (34.0%)	55 (29.6%)	28 (48.3%)	1.000	
COVID-19 infection can be transmitted by respiratory droplets, aerosol, and contact with infected individuals.					
Yes	231 (94.7%)	182 (97.8%)	49 (84.5%)	8.760 (2.406-31.890)	.001
No or unsure	13 (5.3%)	4 (2.2)	9 (15.5%)	1.000	
Healthcare workers, older adults, travelers from overseas, suspected cases of COVID-19, and people who had directly contacted COVID-19 patients are the priority vaccination					

populations.					
Yes	180 (73.8%)	146 (78.5%)	34 (58.6%)	2.587 (1.331-5.029)	.005
No or unsure	64 (26.2%)	40 (21.5%)	24 (41.4%)	1.000	
Persons who are elderly or with underlying diseases or with weakened immunity are more vulnerable to develop COVID-19.					
Yes	204 (83.6%)	160 (86.0%)	44 (75.9%)	1.995 (0.928-4.288)	.08
No or unsure	40 (16.4%)	26 (14.0%)	14 (24.1%)	1.000	

Table 3. Attitude factors associated with the willingness to receive a COVID-19 vaccine among cold-chain food workers in Shenzhen, China, December 2020

Question	N (%)	Willingness of COVID-19 vaccination		OR (95% CI)	*P* value
		Yes	No		
Although the COVID-19 becomes a normalized infectious disease identical to influenza, its social harmfulness is far greater than influenza.					
Agree	212 (86.9%)	167 (89.8%)	45 (77.6%)	2.643 (1.178-5.927)	.02
Disagree or unclear	32 (13.1%)	19 (10.2)	13 (22.4%)	1.000	
COVID-19 infection can lead to severe health and economic burdens.					
Agree	226 (92.6%)	176 (94.6%)	50 (86.2%)	3.109 (1.116-8.660)	.03
Disagree or unclear	18 (7.4%)	10 (5.4%)	8 (13.8%)	1.000	

Table 4. Practice factors associated with the willingness to receive a COVID-19 vaccine among cold-chain food workers in Shenzhen, China, December 2020

Question	N (%)	Willingness of COVID-19 vaccination		OR (95% CI)	*P* value
		Yes	No		
I would take initiative to pay attention to COVID-19-related information.					
Yes	225 (92.2%)	175 (94.1%)	50 (86.2%)	2.260 (0.797-6.411)	.13
No or unsure	19 (7.8%)	11 (5.9%)	8 (13.8%)	1.000	
I have understood more about infectious diseases prevention and control during the COVID-19 pandemic.					
Yes	213 (87.3%)	168 (90.3%)	45 (77.6%)	2.608 (1.115-6.099)	.03
No or unsure	31 (12.7%)	18 (9.7%)	13 (22.4%)	1.000	
I would prevent the COVID-19 infection by maintaining indoor ventilation.					
Yes	212 (86.9%)	167 (89.8%)	45 (77.6%)	2.371 (1.049-5.363)	.04
No or unsure	32 (13.1%)	19 (10.2%)	13 (22.4%)	1.000	
I would prevent the COVID-19 infection by wearing a face mask outside.					
Yes	237	181 (97.3%)	56 (96.6%)	0.777 (0.132-	.78

	(97.1%)			4.588)	
No or unsure	7 (2.9%)	5 (2.7%)	2 (3.4%)	1.000	
I would prevent the COVID-19 infection by washing hands frequently.					
Yes	232 (95.1%)	178 (95.7%)	54 (93.1%)	1.426 (0.391-5.202)	0.59
No or unsure	12 (4.9%)	8 (4.3%)	4 (6.9%)	1.000	
I would prevent the COVID-19 infection by doing more exercises.					
Yes	170 (69.7%)	133 (71.5%)	37 (63.8%)	1.327 (0.696-2.529)	0.39
No or unsure	74 (30.3%)	53 (28.5%)	21 (36.2%)	1.000	
I would prevent the COVID-19 infection by avoiding crowded places.					
Yes	208 (85.2%)	163 (87.6%)	45 (77.6%)	2.053 (0.927-4.545)	0.08
No or unsure	36 (14.8%)	23 (12.4%)	13 (22.4%)	1.000	

Factors Associated with the Willingness to Accept COVID-19 Vaccine

We investigated the factors associated with the willingness towards COVID-19 vaccine usage, which relates to knowledge, attitudes, and practices of COVID-19 and vaccination. Participants who agreed that COVID-19 is a respiratory disease caused by SARS-CoV-2 were 2.31 times more likely to accept the COVID-19 vaccine than those who failed to understand (aOR 2.313, 95%CI 1.098-4.872). As expected, participants' willingness to be vaccinated against COVID-19 was positively correlated with comprehending the most effective measure for preventing COVID-19 (aOR 2.399, 95%CI 1.233-4.666) and recognizing the priority vaccination groups (aOR 2.587, 95%CI 1.331-5.029). Moreover, understanding the transmission routes of COVID-19 infection was considered the most significant factor with an adjusted OR 8.760 and 95%CI 2.406-31.890 (Table 2). In parallel, participants who perceived the social harmfulness of COVID-19 had more likelihood to receive the COVID-19 vaccine (aOR 2.643, 95%CI 1.178-5.927). Perceiving the severity of COVID-19, including health and economic burdens, was another important influencing factor for COVID-19 vaccination among our participants (aOR 3.109, 95%CI 1.116-8.660) (Table 3). Besides, the positive relationships were also observed among participants who attained more understanding related to infectious diseases prevention and control (aOR 2.608, 95%CI 1.115-6.099) and those who contained COVID-19 infection by keeping indoor ventilation (aOR 2.371, 95%CI 1.049-5.363) (Table 4). However, the remaining variables regarding the COVID-19-related KAP were not significantly associated with the dependent variable.

Reasons for Willingness or Not to Receive a COVID-19 Vaccine

Among the 76.2% of participants willing to be vaccinated against COVID-19, the majority (84.4%) elaborated that the COVID-19 vaccination is of vital importance to prevent COVID-19 infection. However, the three main reasons for unwillingness to receive the COVID-19 vaccine included: 51.6% worried about side effects of the COVID-19 vaccine; 50.8% failed to identify the effectiveness; 34.8% would not be vaccinated until it is mature (Figure 1).

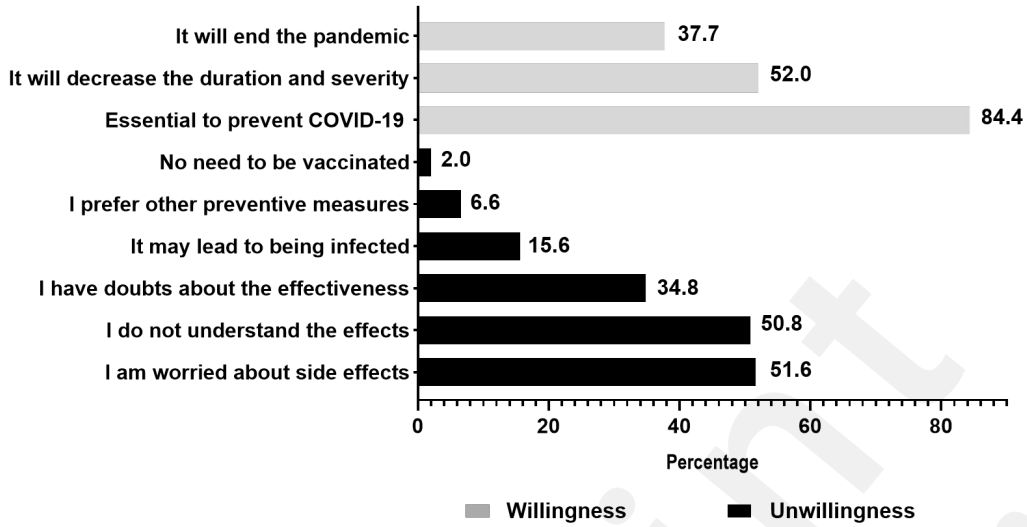

Figure 1. Reasons for willingness or not to receive a COVID-19 vaccine among cold-chain food workers in China.

Discussion

Principal Results

To the best of our knowledge, this cross-sectional survey is expected to be the first to investigate the willingness of COVID-19 vaccination among Chinese cold-chain food workers during the pandemic. Further, we described the levels of knowledge, attitudes, and practices towards COVID-19 and associations between these factors and the willingness to accept COVID-19 vaccination. Among our participants, the majority (76.2%) expressed an intention to be vaccinated against COVID-19, reflecting a relatively high demand for this vaccine among our study population.

As mentioned before, scientific researchers in various countries conducted a series of investigations on accepting COVID-19 vaccination within distinct populations [15, 18-22, 32-34]. A prior study has reported that the prevalence of COVID-19 vaccine acceptance was 73.6% of 7664 adults from six European countries and the United Kingdom (U.K.) [33]. Meanwhile, a relevant study indicated that among general adult populations, 64.9% in Ireland and 69.0% in the U.K. would be willing to get vaccinated for COVID-19 [32]. Another study in the United States reported that 56.0% of U.S. citizens were somewhat or very likely to uptake this vaccine [34]. In

Africa, relevant research showed that only around half of the citizens (56.0%) intended to get vaccinated in the Democratic Republic of Congo [19]. In Asia, it has been demonstrated that nearly 62.1% of Japanese adults had the intention of getting COVID-19 vaccine when it becomes available [35], while an overwhelming of participants in China (91.3%) intended to receive it at the time of it was developed successfully and approve for listing [6]. As discussed previously [35], although our findings are relatively higher than most of these percentages, it is not easy to make an accurate comparison between our study and prior ones due to the differences in questionnaires, populations, the timing of these surveys, and local vaccine policies. Furthermore, several relevant surveys in the same study site (Shenzhen) were found to be similar to our findings, indicating the prevalence of factory workers intended to accept a cost-free COVID-19 vaccine was 80.6% [36], while 72.6% in parental acceptability for their children under the age of 18 years [37]. Vaccination plays a critical role in preventing to be infected among groups at increased risk of COVID-19, and thereby the cold-chain food workers should be advisable to prioritize. Given their high level of exposure to SARS-CoV-2, more investigations in terms of vaccination behaviors are needed for such populations from various countries.

Decision-making of COVID-19 vaccination could be influenced by a variety of factors, including sociodemographic characteristics, understanding, attitudes, and behaviors towards COVID-19 and vaccination, political views, and vaccine policies [35, 38]. Consequently, it is indispensable to evaluate vaccine acceptance and its influencing factors to implement educational activities regarding targeted populations to improve the acceptance of vaccination. In this study, we identified some obstacles in the process of achieving a high acceptance rate for the COVID-19 vaccine. Firstly, insufficient knowledge about COVID-19 and the most effective measure for prevention, and failure to identify priority groups for COVID-19 vaccination were inverse associations with the acceptance to be vaccinated. The factor that primarily hindered the willingness of COVID-19 vaccination was observed among the cold-chain food workers who failed to recognize the transmission routes of COVID-19. Of

these, only 66.0% of cold-chain food workers acknowledged that COVID-19 vaccination is the most effective precaution regarding COVID-19 infection. Interventions targeted at advancing levels of COVID-19-related knowledge might lead to increased vaccination rates. Secondly, our participants who have perceived social harmfulness and seriousness of COVID-19 were more likely to intend to receive a COVID-19 vaccine, consistent with previous surveys [32, 35]. This suggested that the perception of the study population acquires to be enhanced, as the perception of high risk would translate into preventive behaviors with respect to infectious diseases and would be helpful for epidemic prevention and control [5, 39]. Finally, increased associations with the willingness to be vaccinated were observed in participants who self-reported that they have obtained more education on prevention and control for infectious diseases and those who prevented COVID-19 infection through maintaining indoor ventilation.

As expected, most subjects (97.1%) preferred to take measures against COVID-19 infection by wearing a mask outside, while the lowest frequency was through doing more exercises in this issue. This observation seemed to be owing to the recommended precautions for COVID-19 by the Chinese government. However, no significant association was found between demographic variables and the willingness of COVID-19 vaccination in the present study (data not shown). The small sample size of this study might be the possible reason for this result. Therefore, further investigation with larger populations should be carried out to determine whether the willingness to get vaccinated would differ across demographic factors among cold-chain food workers.

Despite the finding that most of our study population presented a willingness to be vaccinated against COVID-19, it is meaningful to investigate the possible wherefores for their vaccination decision on whether to accept vaccination [6]. In the group that intended to receive a COVID-19 vaccine, many participants (84.4%) believed that this vaccine is of vital importance to prevent COVID-19 infection. In contrast, others considered the COVID-19 vaccination would reduce the duration and severity of

COVID-19 (52.0%) and even stop the ongoing pandemic (37.7%). Regarding the group that refused to be vaccinated, the most frequent reason was concerning about side effects of the COVID-19 vaccine (51.6%), followed by failure to understand its efficacy (50.8%). These coincided with several prior studies explaining the reasons for the unwillingness of the COVID-19 vaccine [6, 22]. A previous study reported that 16.6% and 28.5% out of 3195 Chinese adults were worried about the safety and side effects of the COVID-19 vaccine, respectively, although they intended to be vaccinated [5]. Another prior study also indicated that the safety and side effects of influenza vaccines were considered the most common reasons for vaccination hesitancy [40]. Moreover, public concerns related to vaccine safety and adverse events have been reported frequently as the main barriers to vaccination decision-making, especially for recently introduced vaccines that have not been thoroughly tested [6, 9, 10, 41]. Hence, great efforts are warranted for addressing public misconceptions about vaccine safety and side effects.

In addition to the practical steps against COVID-19 mentioned before, a combination of border control and quarantine measures also validly contain the spread of the virus from infected travelers [25]. While a number of localized outbreaks still occurred by other potential transmission routes, such as the food-to-human route, since the COVID-19 virus could survive for more than 21 days on cold-chain food and food packaging during low-temperature transportation [27]. These make the SARS-CoV-2 infect cold-chain food workers through direct contact with the stuff. Therefore, keeping these workers healthy and safe is critical for themselves, their families, the consumers, and even for the whole society. In this regard, health authorities should pay more attention to advancing these workers' personal protection for better epidemic prevention and control shortly.

Limitations

Some potential limitations must be acknowledged. First, the targeted population consisted of cold-chain food workers from a single center that was not generalizable to all cold-chain food workers in China. Second, the collected information might be

subject to recall bias due to the utilization of self-reported questionnaires given this critical moment.

Conclusions

Overall, this population-based study indicated that 76.2% of cold-chain food workers expressed a willingness to be vaccinated against COVID-19. Knowledge, attitudes, and practices towards COVID-19 were significant factors associated with the COVID-19 vaccine acceptance. Agreement on the importance of vaccination to prevent COVID-19 was the most frequent reason for accepting the COVID-19 vaccine. At the same time, concerns about side effects and poor understanding of efficacy were the main factors contributing to the vaccination refusal. Addressing barriers to vaccination among these groups may be the key to promote vaccine acceptance. Given that public awareness of vaccines might not keep up with vaccine development speed, we suggest that educational activities should be promptly implemented in light of the updated vaccine situations to increase future acceptance of the COVID-19 vaccine.

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Conflicts of Interest

None declared.

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Abbreviations

COVID-19: Coronavirus disease 2019

SARS-CoV-2: severe acute respiratory syndrome coronavirus 2

KAP: knowledge, attitudes, and practices

aOR: adjusted odds ratio

CI: confidence interval

WHO: World Health Organization

CDC: Center for Disease Control and Prevention