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An Asia-Pacific study on healthcare workers' perceptions of, and willingness to receive, the COVID-19 vaccination



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ABSTRACT

Objective: In the fight against COVID-19, vaccination is vital in achieving herd immunity. Many Asian countries are starting to vaccinate frontline workers; however, expedited vaccine development has led to hesitancy among the general population. We evaluated the willingness of healthcare workers to receive the COVID-19 vaccine.

Methods: From 12 to 21 December 2020, we recruited 1720 healthcare workers from 6 countries: China, India, Indonesia, Singapore, Vietnam and Bhutan. The self-administrated survey collected information on willingness to vaccinate, perception of COVID-19, vaccine concerns, COVID-19 risk profile, stigma, pro-socialness scale, and trust in health authorities.

Results: More than 95% of the healthcare workers surveyed were willing to vaccinate. These respondents were more likely to perceive the pandemic as severe, consider the vaccine safe, have less financial concerns, less stigmatization regarding the vaccine, higher pro-socialness mindset and trust in health authorities. A high perceived pandemic risk index, low vaccine harm index and high pro-socialness index were independent predictors in multivariable analysis.

Conclusions: The majority of healthcare workers in Asia are willing to receive COVID-19 vaccination. Perceived COVID-19 susceptibility, low potential risk of vaccine harm and pro-socialness are the main drivers. These findings may help formulate vaccination strategies in other countries.

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Introduction

More than 50 vaccines for COVID-19 are either undergoing clinical trials or already approved for limited use in some countries (World Health Organization, 2020b). Successful universal vaccination is considered to be the next big step in the fight against the contagion. While China started vaccinating frontline healthcare workers with its vaccine in early July 2020 (Helen, 2020), on December 30, 2020, Singapore became the first in Asia to authorize Tozinameran from Pfizer-BioNTech for use in healthcare workers (Singapore Ministry of Health, 2020). Other countries in Asia plan to follow suit in early 2021. However, vaccination effectiveness depends on the proportion of uptake by the population and hesitancy for receiving the vaccine is a major obstacle to combating the COVID-19 pandemic. Accordingly, the World Health Organization (WHO) listed vaccine hesitancy as one of the top 10 global health threats in 2019 (World Health Organization, 2019).

In 2015, the WHO's strategic advisory group of experts on vaccine hesitancy defined it as a 'delay in acceptance or refusal of vaccination despite availability of vaccination services'. It is a complex issue influenced by confidence, complacency and convenience factors (Singapore Ministry of Health, 2020). While only a minority hold strong anti-vaccination sentiment, the proportion of vaccine-hesitant may increase (World Health Organization, 2019). A 2016 survey assessing vaccine confidence across 67 countries found that the sentiment was overall positive in all countries but with wide variability. Vaccine-safety confidence was lowest in Europe and highest in South East Asia (MacDonald, 2015). Similarly, a 2020 survey assessing the potential acceptance of the COVID-19 vaccine in 13 426 individuals across 19 countries found significant heterogeneity in different countries' responses (Dubé et al., 2015).

As healthcare workers continue to remain on the frontline during the current pandemic (Chew et al., 2020a; Chew et al., 2020b; Tan et al., 2020), countries have prioritized them to be the first to receive the vaccine (Sun et al., 2021). However, there have been increasing reports on hesitancy in receiving the vaccine among the general public in European countries (Lazarus et al., 2021). The willingness to receive the COVID-19 vaccine among healthcare workers in Asia remains unknown. This multicenter, multinational study sought to examine healthcare workers' willingness to receive the COVID-19 vaccination and their concerns regarding the vaccine and various factors responsible for hesitancy, if any. We also aimed to identify independent predictors of willingness to receive the COVID-19 vaccine. Given reported reluctance among the global population to receive the vaccine (Lazarus et al., 2021), our findings may have implications for establishing appropriate strategies to improve vaccination compliance among frontline healthcare workers.

Methods

Survey development and administration

Following a structured review of the literature, a cross-sectional electronic survey was designed by a group of multidisciplinary researchers from 6 countries in the Asia-Pacific region: India, China, Singapore, Vietnam, Indonesia and Bhutan. The survey was uploaded and administered via the Google online survey platform and open to all healthcare workers from the Asia-Pacific region. From 12 to 31 December 2020, a link to the electronic survey was distributed via various methods, including invitation via email and secure social media platforms. Permission to conduct the study was sought from the Zydus Hospitals Ethics Committee (Ref: 2020/12/10). A statement of informed consent was provided on the first page of the questionnaire, and all responses were anonymous.

Participants' responses were kept confidential according to Google's privacy policy.

Survey questionnaire

Information was collected on participants' demographic characteristics, socioeconomic status, occupation and past medical history. The detailed questionnaire is presented as supplementary material.

The survey questionnaire was segregated into 7 parts:

- 1) *Willingness to receive the vaccine.* A single item assessed this: "I would be willing to receive a COVID-19 vaccine if it was safe, available and recommended". Willingness to receive the COVID-19 vaccine was dichotomized (1 = willing; 0 = not willing) (Sun et al., 2021).
- 2) *Perception of the COVID-19 pandemic and vaccine.* A total of 3 items assessed the perception of the pandemic and the vaccine.
- 3) *Concerns about the vaccine.* This item was subdivided into 3 components: a) physical harm index (5 items) assessing the participant's perception of anticipated harm by the vaccine; b) financial concerns related to the vaccine (1 item); and c) other concerns (4 items). The physical harm index was adapted from the established survey on willingness to participate in HIV-1 vaccine trials (Jenkins et al., 2000).
- 4) *COVID-19 risk profile.* This item had 9 items assessing the direct impact of COVID-19 infection on the participant's personal, family and social life.
- 5) *Internalized stigma related to receiving the COVID-19 vaccine.* The participant's internalized stigma of receiving the COVID-19 vaccine was assessed with 3 items adapted from the Perceived External Stigma item of the Ebola-related Stigma Questionnaire (Overholt et al., 2018).
- 6) *Pro-socialness scale.* To assess the participant's pro-socialness stance on the COVID-19 vaccine, 4 components were adapted from the Pro-socialness Scale for Adults (Caprara et al., 2005).
- 7) *Trust in health authorities.* The participant's trust in the healthcare and government sector during the pandemic was assessed with 5 items encompassing various components of public trust (including the participant's overall perception of trust in health authorities and perception of the authorities' competency, fairness, honesty, and confidentiality) adapted from the well-established Public Health Disaster Trust Scale (Eisenman et al., 2012).

The Likert scale was used to assess participants' responses (1 = strongly agree; 2 = agree; 3 = neutral; 4 = disagree; 5 = strongly disagree).

Study outcomes

The primary study outcome was the willingness to receive the COVID-19 vaccine if it was safe, available and recommended by health authorities. We also explored the independent predictors of the willingness to receive the COVID-19 vaccine.

Conceptually related items were combined into composite outcomes for further analyses to improve the efficiency of the logistic model (Jenkins et al., 2000). The perceived risk index evaluated participant perception of their risk in the pandemic, which included the following components: "the current COVID-19 pandemic is severe", "I am at risk of contracting COVID-19" and "How much do you feel that the COVID-19 pandemic has affected your daily life". The physical harm index assessed participant perception of the potential physical harm of the vaccine to themselves and included the following components: "I am worried about potential vaccine side effects", "I am worried about death or

Table 1
Baseline characteristics of study participants categorised according to their willingness to receive the COVID-19 vaccination.

	All participants (N = 1720)	Willing to vaccinate (n = 1655)	Not willing to vaccinate (n = 65)	p-Value
Age (years)	33 (9)	33 (9)	32 (9)	0.460
Sex (female)	1050 (61.0)	1009 (61.0)	41 (63.1)	0.732
Country				0.163
India	406 (23.6)	378 (23.4)	19 (29.2)	
China	303 (17.6)	288 (17.4)	15 (23.1)	
Vietnam	472 (27.4)	463 (28.0)	9 (13.8)	
Indonesia	430 (25.0)	411 (24.8)	19 (29.2)	
Singapore	61 (3.5)	58 (3.5)	3 (4.6)	
Bhutan	47 (2.7)	47 (2.8)	0	
Marital status				0.678
Single	627 (36.5)	598 (36.1)	29 (44.6)	
Married	1054 (61.3)	1019 (61.6)	35 (53.8)	
Separated	8 (0.5)	8 (0.5)	0	
Divorced	27 (1.6)	26 (1.6)	1 (1.5)	
Widow	4 (0.2)	4 (0.2)	0	
Has children or dependents	823 (47.8)	800 (48.3)	23 (35.4)	0.040
Smoking status				0.922
Current	79 (4.6)	79 (4.6)	3 (4.6)	
Ex-smoker	128 (7.4)	124 (7.5)	4 (6.2)	
Non-smoker	1513 (88.0)	1455 (87.9)	58 (89.2)	
Housing				0.724
1-room flat	165 (9.6)	158 (9.5)	7 (10.8)	
2 room flat	166 (9.7)	162 (9.8)	4 (6.2)	
3-room flat	302 (17.6)	287 (17.3)	15 (23.1)	
4-room flat	83 (4.8)	82 (5.0)	1 (1.5)	
5-room flat	52 (3.0)	50 (3.0)	2 (3.1)	
Condominium	75 (4.4)	72 (4.4)	3 (4.6)	
Landed housing	877 (51.0)	844 (51.0)	33 (50.8)	
Religion				0.979
Non-religious	720 (41.9)	699 (42.2)	21 (32.3)	
Christianity	104 (6.0)	98 (5.9)	6 (9.2)	
Islam	412 (23.9)	395 (23.8)	17 (26.2)	
Buddhism	113 (6.6)	110 (6.6)	3 (4.6)	
Daoism	3 (0.2)	3 (0.2)	0	
Hinduism	352 (20.6)	334 (20.3)	18 (27.7)	
Confucianism	2 (0.1)	2 (0.1)	0	
Others	14 (0.8)	14 (0.8)	0	
Currently employed during pandemic				
Annual household income				0.095
Less than USD \$25,000	1349 (78.4)	1301(78.6)	48 (73.8)	
USD \$25,000–34,999	148 (8.6)	141 (8.5)	7 (10.8)	
USD \$35,000–49,999	69 (4.0)	62 (3.7)	7 (10.8)	
USD \$50,000–74,999	60 (3.5)	60 (3.6)	0	
USD \$75,000–99,999	39 (2.3)	38 (2.3)	1 (1.5)	
More than USD \$100,000	55 (3.2)	53 (3.2)	2 (3.1)	
Education level				0.312
No formal education	5 (0.3)	5 (0.3)	0	
Less than high school	2 (0.1)	2 (0.1)	0	
High school	84 (4.9)	84 (5.1)	0	
Undergraduate	698 (40.5)	667 (40.3)	31 (47.7)	
Postgraduate	180 (10.5)	177 (10.7)	3 (4.6)	
Occupation				0.269
Physician	892 (51.8)	859 (51.9)	33 (50.7)	
Nurse	404 (23.5)	389 (23.5)	15 (23.1)	
Allied healthcare	184 (5.1)	179 (10.8)	5 (7.7)	
Medical students	19 (1.1)	18 (1.1)	1 (1.5)	
Technician	55 (3.2)	52 (3.1)	3 (4.6)	
Clerical staff	14 (0.8)	14 (0.8)	0	
Administrator	69 (4.0)	65 (3.9)	4 (6.2)	
Maintenance worker	12 (0.7)	10 (0.6)	2 (3.1)	
Others	71 (4.1)	69 (4.2)	2 (3.1)	
Presence of medical condition	213 (12.4)	203 (12.3)	10 (15.4)	0.454
Hypertension	108 (6.3)	101 (6.1)	7 (10.8)	0.128
Hyperlipidemia	192 (11.2)	182 (11.0)	10 (15.4)	0.271
Diabetes mellitus	44 (2.6)	41 (2.5)	3 (4.6)	0.284
Previous myocardial infarction	15 (0.9)	13 (0.8)	2 (3.1)	0.051
Previous heart failure	3 (0.2)	1 (0.1)	2 (3.1)	<0.001
Atrial fibrillation	45 (2.6)	42 (2.5)	3 (4.6)	0.303
Other heart problems	33 (1.9)	30 (1.8)	3 (4.6)	0.106
Asthma	84 (4.9)	75 (4.5)	9 (13.8)	<0.001
Chronic obstructive pulmonary disease	10 (0.6)	9 (0.5)	1 (1.5)	0.301
Obstructive sleep apnea	25 (1.5)	24 (1.5)	1 (1.5)	0.953
Other lung problems	35 (2.0)	33 (2.0)	2 (3.1)	0.544
Cancer	11 (0.6)	10 (0.6)	1 (1.5)	0.354
Anxiety	171 (9.9)	161 (9.7)	10 (15.3)	0.135
On long-term medications	493 (28.7)	472 (28.5)	21 (32.3)	0.508

Table 1 (Continued)

	All participants (N = 1720)	Willing to vaccinate (n = 1655)	Not willing to vaccinate (n = 65)	p-Value
On private health insurance	854 (49.7)	830 (50.2)	24 (36.9)	0.111
Engages in regular physical activity	747 (43.4)	731 (44.2)	16 (24.6)	0.002

p < 0.05 denotes statistical significance.

permanent handicap from the vaccine”, “I am worried that I would become sick sooner if I were to take the vaccine”, “I am worried about contracting COVID-19 from the vaccine” and “I am concerned over potential allergy to vaccine”. The COVID-19 risk profile encompasses those who had suffered from COVID-19 infection from their personal and/or family’s experience. Internalized stigma from receiving the vaccine involves the following 3 items: “I would feel stigmatized if I contracted COVID-19”, “I am worried that others may refuse to have contact with me if I were to receive the vaccine” and “I am worried that others may think that I have COVID-19 if I were to receive the vaccine”. The pro-socialness scale index was defined by 4 items: “it is my social responsibility to ensure that I am adequately protected/vaccinated against COVID-19”, “I am willing to receive other vaccines e.g. the influenza vaccine”, “I am intending to/have already been vaccinated against the flu” and “It is everyone’s social responsibility to get vaccinated barring any contraindications”. Participant trust in health authorities encompassed the following items: “I have trust in my country’s public healthcare system/government”, “my country’s public healthcare system/government has responded effectively to the COVID-19 pandemic”, “I am confident that my country’s public healthcare system / government will respond fairly to my health needs regardless of my race, ethnicity, income or other personal characteristics”, “my country’s public healthcare system/government has provided honest information/been transparent about the COVID-19 pandemic to the public” and “I am confident that the personal data (such as my race, income and citizenship) collected by my country’s government will not be used against me”. Selecting the options of “strongly agree” or “agree” to any of the items within each index was taken as an affirmative endorsement.

Statistical analyses

Continuous variables were expressed as mean value (\pm SD), while categorical variables were expressed as absolute values (percentage). Continuous variables were compared using Student’s t-test, while categorical variables were examined using Pearson’s chi-squared test (or Fisher’s Exact Test, where appropriate). The comparison of the prevalence of psychological outcomes among the 6 countries was performed using logistic regression. Multivariable logistic regression was performed to evaluate for independent predictors of the willingness to receive the COVID-19 vaccination among healthcare workers. The important variables included in the regression model were non-medical healthcare workers, presence of private health insurance, presence of children or dependents, presence of a medical condition, perceived risk index, physical harm index, financial concern, personal risk profile, internalized stigma, pro-socialness index and trust in health authorities. A P-value of <0.05 was deemed significant for this study. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY.

Results

Participants

Of the 1909 healthcare workers invited to participate in this study, 1720 (90.1% response rates) agreed to participate in the

study. There were 472 (27.4%) participants from Vietnam, 430 (25.0%) from Indonesia, 406 (23.6%) from India, 303 (17.6%) from China, 61 (3.6%) from Singapore, and 47 (2.8%) from Bhutan. The majority of participants were female, with a mean age of 33 (\pm 9). Most participants were medically trained (n = 1296, 75.3%), 68.8% (n = 892) of whom were physicians and 31.2% (n = 404) were nurses. The remaining personnel were non-medically trained, most of whom were allied healthcare workers (n = 184, 5.1%), followed by administrators (n = 69, 4.0%). The baseline characteristics are presented in Table 1.

Willingness to receive vaccination

The majority of study participants (n = 1655, 96.2%) expressed willingness to receive the COVID-19 vaccine if it was safe, available and recommended. There was no significant difference in the proportion of healthcare workers willing to receive the COVID-19 vaccination across the 6 participating countries (P = 0.163). The percentage of healthcare workers who were willing to get vaccinated in each country are depicted in Figure 1.

Univariate analyses indicated that those who were willing to vaccinate were more likely to have children or dependents than those who were unwilling (48.3% vs 35.4% respectively, P = 0.040). Those willing to vaccinate were also more likely to engage in regular physical activity (P = 0.002). Participants with a higher prevalence of physical comorbidities such as previous heart failure (P < 0.001) and asthma (P < 0.001) were more likely to be unwilling to vaccinate. Participants with private health insurance showed a non-significant trend towards willingness to vaccinate (P = 0.111).

Perception of the COVID-19 pandemic and vaccine

The frequency of responses on the participants’ perception, concerns, risk profile, internalized stigma, pro-socialness attitude, and trust in health authorities regarding the COVID-19 vaccine are displayed in Figure 2.

Participants who were willing to vaccinate were more likely to perceive that “the current COVID-19 pandemic was severe” (P < 0.001) and that “the COVID-19 pandemic has affected [their] daily life” (P = 0.002).

On the perception of the COVID-19 vaccine, those who were willing to vaccinate were more likely to have the “belief that vaccines in general are safe and effective” (P < 0.001) and that the “vaccine would allow life to return to normal” (P < 0.001), and were less likely to “prefer the current measures such as social distancing, wearing mask over vaccination” (P < 0.001).

Participants’ concerns about the COVID-19 vaccine

With regards to the concerns of physical harm from the COVID-19 vaccine, those who were willing to vaccinate were less likely to be “worried about potential vaccine side effects” (P = 0.001), “worried about death or permanent handicap from the vaccine” (P = 0.005), “worried that [they] would become sick sooner if [they] were to take the vaccine” (P < 0.001), “worried about contracting COVID-19 from the vaccine” (P < 0.001), and “concerned over potential allergy to the vaccine” (P = 0.001).

Healthcare workers' willingness to receive COVID-19 vaccination by country

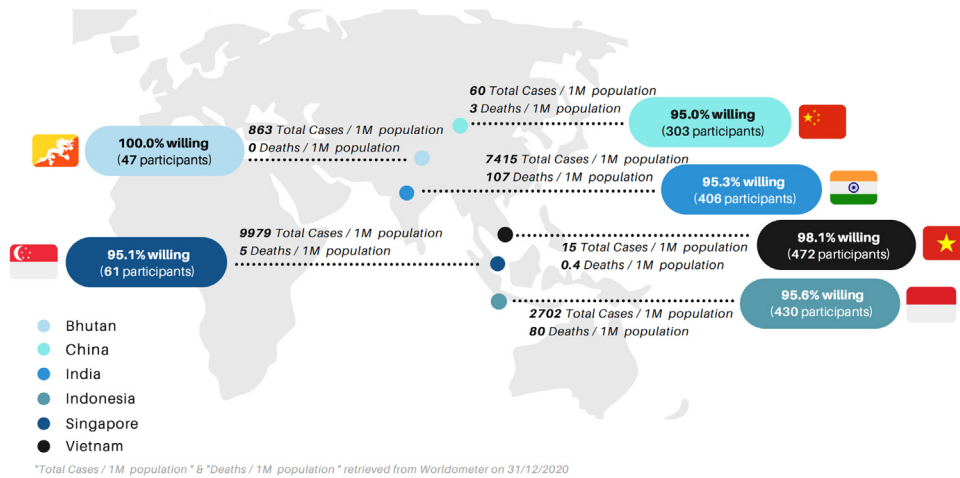


Figure 1. Percentage of healthcare workers willing to receive the COVID-19 vaccination, by country.

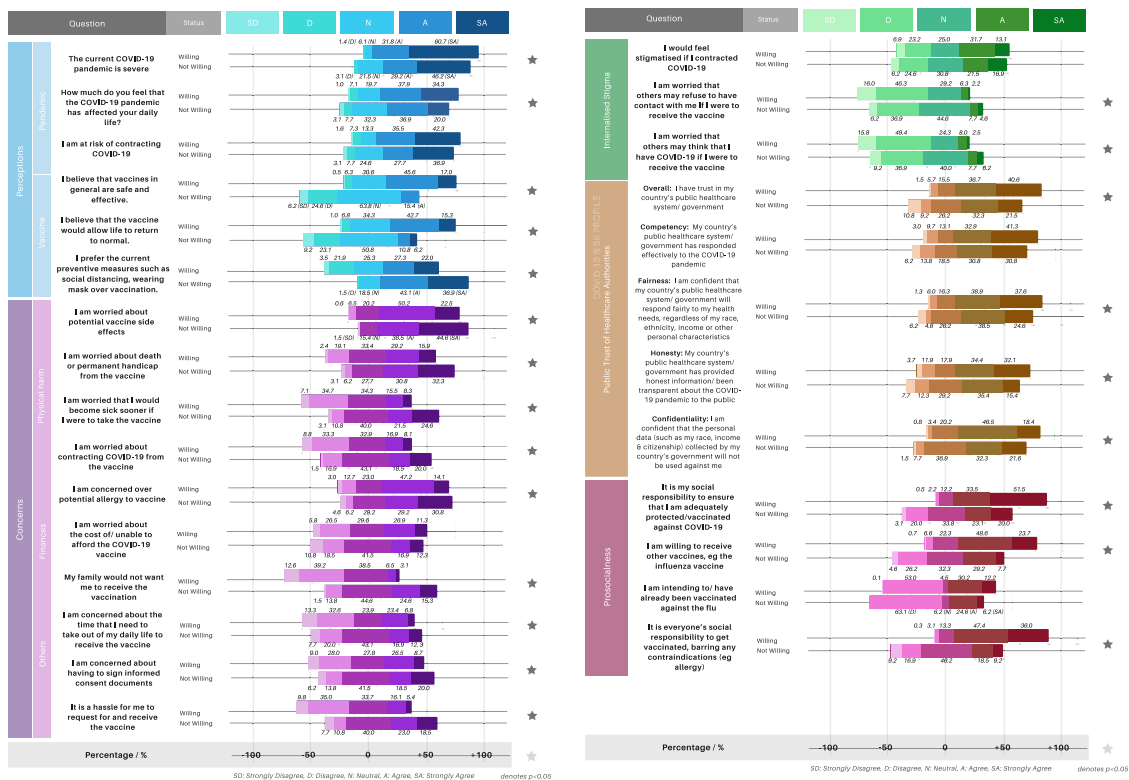


Figure 2. The frequency of responses on the participant perception, concerns, risk profile, internalized stigma, pro-socialness attitude, and trust in health authorities regarding the COVID-19 vaccine. The frequency of responses between the 2 groups (willing and unwilling to vaccinate) compared using Pearson's chi-squared test. $P < 0.05$ denotes statistical significance.

There was a trend towards a higher proportion of participants expressing financial concerns (“I am worried about the cost of/ unable to afford the COVID-19 vaccine”) among those who were willing to vaccinate, but this did not reach statistical significance ($P = 0.062$). In terms of the maximum amount of money that participants were willing to spend on the vaccine, the majority of the participants in both groups (willing to vaccinate vs unwilling to vaccinate) chose the option “free of charge” (willing to vaccinate

42.4% vs unwilling to vaccinate 61.5%), followed by “up to \$50 USD” (38.5% vs 27.7%), and “\$100 USD” (13.2% vs 10.8%). Only 3.7% and 2.1% of participants willing to vaccinate chose “\$250 USD” and “ \geq \$500 USD”, respectively ($P = 0.044$).

Apart from physical harm and financial concerns regarding the vaccination, the 2 groups had significantly different frequencies of responses related to other external concerns. Those who were willing to vaccinate were less likely to *strongly agree or agree* that

“family would not want [them] to receive the vaccination” ($P < 0.001$) and that “it [was] a hassle for [them] to request for and receive the vaccination” ($P < 0.001$).

Participants' COVID-19 risk profile

Figure 3 displays the responses regarding participant COVID-19 risk profile; these were divided into 2 components: 1) individual and 2) family members. When comparing individuals or family members who suffered or did not suffer from COVID-19 infection, there was no significant difference in the proportion of participants willing to vaccinate ($P = 0.422$ and $P = 0.463$, respectively).

Internalized stigma and pro-socialness scale

Internalized stigma was assessed by 3 items, of which 2 items had a significant difference in responses. A lower proportion of the group willing to vaccinate strongly agreed that they were “worried that others may refuse to have contact with [them] if [they] were to receive the vaccine” ($P = 0.028$) and that they were “worried that others may think [they] have COVID-19 if [they] were to receive the vaccine” ($P = 0.009$).

Determinants of pro-socialness received a significantly different response between the 2 groups. Those who were willing to vaccinate were more likely to agree or strongly agree that “it is [their] social responsibility to ensure that [they are] adequately protected/vaccinated against COVID-19” ($P < 0.001$), [they are] “willing to receive other vaccines, e.g. the influenza vaccine” ($P < 0.001$) and “it is everyone’s social responsibility

to get vaccinated, barring any contraindications (e.g. allergy)” ($P < 0.001$).

Trust in health authorities

Trust in health authorities was evaluated using 5 components: 1) overall perception – a larger proportion of those willing to vaccinate were more likely to “have trust in the country’s public healthcare system/government” ($P < 0.001$); 2) competency – a higher proportion of those willing to vaccinate were more likely to hold the belief that the “country’s public healthcare system/government has responded effectively to the COVID-19 pandemic”, although this did not reach statistical significance ($P = 0.286$); 3) fairness – a significantly larger proportion of participants were “confident that [their] country’s public healthcare system/government will respond fairly to [their] health needs regardless of race, ethnicity, income or personal characteristics” ($P = 0.006$); 4) honesty – participants willing to vaccinate were more likely to believe that the “country’s public healthcare system/government has provided honest information/been transparent about the COVID-19 pandemic to the public” ($P = 0.014$); 5) confidentiality - those willing to vaccinate were more likely to be “confident that the personal data collected by [their] country’s government will not be used against [them]” ($P = 0.006$).

Independent predictors of the willingness to receive vaccination

Multivariate analysis of healthcare workers was performed to assess independent predictors of willingness to vaccinate. After



Figure 3. The COVID-19 risk profile of participants and family members and willingness to receive the COVID-19 vaccination.

adjusting for the important covariates, the clinical predictors of willingness included an increased perceived risk of COVID-19 index (adjusted odds ratio [aOR] 5.082, 95% CI 2.223–11.617, $P < 0.001$), a decreased physical harm of the vaccine index (aOR 0.402, 95% CI 0.170–0.948, $P = 0.037$), and an increased pro-socialness index (aOR 7.359, 95% CI 4.163–13.007, $P < 0.001$) (Table 2).

Discussion

Our multinational, multicenter study describes the complex psychosocial dynamics influencing frontline healthcare workers' willingness to receive the COVID-19 vaccine. The main findings of the study were: 1) >95% of healthcare workers, regardless of geographical location in Asia, were willing to receive the COVID-19 vaccine; 2) participants who were willing to vaccinate were more likely to have the perception that the pandemic was severe and the vaccine was safe and effective, had less financial concerns, felt less internalized stigma about the vaccine, expressed altruism (or pro-socialness), and trusted the healthcare authorities; 3) the independent predictors of willingness to vaccinate included a high perceived risk of COVID-19 index, lower physical harm from the vaccine index and increased pro-socialness index. Our findings may have important implications for the strategies needed in personalized counselling and educational initiatives to cultivate a more positive response to vaccination among frontline healthcare workers.

While the new vaccine against COVID-19 is rapidly distributed across the globe in an effort to curb the COVID-19 pandemic, vaccine hesitancy among the general population remains one of the main hindrances for achieving adequate COVID-19 herd immunity. Our study on healthcare workers across Asia records a high overall percentage of willingness to receive the vaccine, with only 3.8% of study participants expressing unwillingness. Our findings are consistent with a general population study from China, where a low proportion of participants (0.7%) were unwilling to receive the vaccine (Lazarus et al., 2021). However, our findings contrast with studies in Europe and the US which reported higher percentages of respondents stating unwillingness to receive the vaccine; 15%–26% in Italy (Graffigna et al., 2020b), 26% in France (Peretti-Watel et al., 2020), 29% in Poland (Feleszko et al., 2020) and 20% in the US (Thunstrom et al., 2020). These levels of unwillingness to vaccinate against COVID-19 are worryingly higher than the level of unwillingness for the usual vaccines (Feleszko et al., 2020). There is uncertainty that each population can reach the intended 67% necessity to reach the herd immunity threshold (Graffigna et al., 2020b).

Considerable difference in the willingness to get vaccinated in Asian vs European countries has been described by Lazarus et al. (2021), where countries that exceeded 80% tended to be Asian, with their general public having a strong trust in central

governments such as those in China, Singapore and South Korea. Pro-socialness and social responsibility for community immunity may also be innate cultural factors within the Asian community that improve vaccination willingness. More studies are needed to understand better the cultural factors contributing to the wide variation in willingness to vaccinate. We are encouraged to report a lower percentage of unwillingness to vaccinate in our relatively younger study cohort, given that young people have been described as more likely to have “invulnerability bias” and are considered to be the most hesitant age group for the COVID-19 vaccine (Barello et al., 2020; Neumann-Böhme et al., 2020; Taylor, 2019). Overall, there is a need to foster general positive attitudes towards being proactive in health self-management and health promotion, enabling individuals to perceive themselves as co-responsible for their health and public health.

Our findings highlight the difference in perceptions amongst healthcare workers with regards to the vaccine. Understanding the social, demographic, and psychological determinants may help adjust the psychological levers to increase willingness to vaccinate and drive the success of each country's immunization strategy. Accordingly, while adopting a psychological lens, we demonstrated that perceived susceptibility towards the COVID-19 pandemic was an independent predictor of willingness to vaccinate. The perceived safety profile of the vaccine correlated with willingness to vaccinate, aligning with previous studies where willingness to vaccinate was affected by the perceived severity of COVID-19, extent of personal vulnerability to the virus, and effectiveness and safety of the vaccine (Dror et al., 2020; Harrison and Wu, 2020). This evidence suggests how willingness to vaccinate is framed by the health promotion information disseminated to the public about the severity of the pandemic and vaccine safety. An important finding was that 50% of those willing to vaccinate agreed that the current social distancing measures were more important than vaccination, highlighting that those willing to vaccinate are not free of misconceptions around the importance of vaccination. All of the public, regardless of willingness to vaccinate, should receive timely educational campaigns and broadcasts to foster accurate and transparent information to enhance proactive vaccination-related behaviors and understanding of the importance of vaccination.

Although all countries are trying to expedite vaccination for COVID-19, various misconceptions, health beliefs, conspiracy theories, and concerns for the safety and effectiveness of the vaccine play an important role in the willingness of various population groups to accept the vaccination (Harrison and Wu, 2020; Puri et al., 2020). Anecdotally, the accelerated pace of vaccine development has evoked the public's hesitancy and various concerns about the vaccine (Fadda et al., 2020). Our study identified that potential physical harm, death or permanent handicap due to the vaccine, contracting the virus, and lack of

Table 2

Univariate and multivariate logistic analysis of the willingness to receive the COVID-19 vaccination amongst healthcare workers.

	Odds ratio (95% CI)	P-value	Adjusted odds ratio (95% CI)	P-value
Non-medical healthcare workers	1.086 (0.618–1.910)	0.774	1.326 (0.728–2.416)	0.357
Private health insurance	1.719 (1.029–2.870)	0.038	1.813 (1.017–3.231)	0.044
Presence of children or dependents	1.709 (1.018–2.867)	0.042	1.463 (0.699–3.063)	0.312
Presence of medical condition	1.300 (0.653–2.592)	0.455	1.463 (0.699–3.063)	0.312
Perceived risk index	4.152 (2.184–7.892)	<0.001	5.082 (2.223–11.617)	<0.001
Physical harm index	0.738 (0.361–1.508)	0.405	0.402 (0.170–0.948)	0.037
Financial concern index	0.670 (0.389–1.154)	0.149	0.804 (0.447–1.446)	0.467
Personal risk profile	1.461 (0.888–2.403)	0.136	1.266 (0.697–2.298)	0.438
Internalised stigma	0.909 (0.553–1.495)	0.708	0.990 (0.569–1.721)	0.971
Prosocialness index	9.171 (5.412–15.541)	<0.001	7.359 (4.163–13.007)	<0.001
Public's trust of health authorities	2.349 (1.311–4.209)	0.004	1.209 (0.626–2.334)	0.572

p < 0.05 denotes statistical significance.

time to receive multiple vaccination shots are important hindrances in the vaccination drive. The largest proportion of participants was willing to receive the vaccination if it was free of charge. During the peak of the dengue endemic, the mean amount that the public agreed to pay for the dengue vaccine was US \$26.1 in Vietnam, US \$69.8 in Thailand, US \$20–22.6 in Columbia (Lee et al., 2015), US \$33.6 in Brazil (Godói et al., 2017) and US \$27.1–32.3 in the Philippines (Palanca-Tan, 2008). Perhaps, the general public considers that controlling the COVID-19 virus is the responsibility of the state. Although vaccine hesitancy has been deemed harmful, there may be some positives in this phenomenon. In the Dengvaxia controversy in the Philippines vaccine hesitancy and a careful risk management plan helped to saved lives. Therefore, a degree of vaccine hesitancy among both health authorities and the general public might help maintain vigilance in the continuous assessment of vaccinations, especially newer and riskier vaccines (Fatima and Syed, 2018).

Studies have shown that an individual's level of health engagement is influenced by the perception of their susceptibility to COVID-19 related health issues and that health engagement was a good predictor of individual preventive attitudes in the COVID-19 pandemic (Castellini et al., 2020; Graffigna et al., 2020a; Nania et al., 2020). We found that those who would normally engage in regular physical activity were more willing to vaccinate. The large majority of healthcare workers were willing to vaccinate regardless of their COVID-19 status and risk profile.

The perceived societal stigma surrounding COVID-19 infection may decrease the willingness to receive the vaccine due to concerns of getting infected from the vaccine. A study on Ebola survivors demonstrated that the pervasiveness of internalized stigma led to long-term emotional and physical sequelae due to concerns of possible recrudescence long after recovery. Mitigation efforts are needed to minimize stigma during and after outbreaks through community education and survivor counseling, involvement of popular opinion leaders such as religious figures, and disseminating accurate, stigma-reducing messages at the local level (Overholt et al., 2018).

Throughout history, there has been a hesitancy to trust health authorities for vaccination of viruses such as HIV, human papillomavirus and poliovirus (Karafillakis et al., 2019; Strauss et al., 2001). Our study found that participants who had trust in health authorities were more likely to accept the vaccine, although the association was not strong. In a study by Sun et al. (2021), mistrust in public health decreased the likelihood of willingness to participate in the vaccine trial. Lessons from the previous infectious disease outbreaks of HIV, Severe Acute Respiratory Syndrome, Middle East Respiratory Syndrome-related coronavirus and Ebola reinforce that clear and consistent communication by health authorities is needed to build trust and confidence among the public. This communication includes comprehensive and transparent explanations of how vaccines work, how they are developed, the time needed to reach an effective level (requirement of multiple doses), contingency management plans in situations of unexpected health adverse effects, and the importance of herd immunity. It is important to strike a good balance between educating the public on the importance of universal vaccine coverage and avoiding the suggestion of coercion from the government. Validated, widely respected and impartial health groups such as the Red Cross may have an important role in building trust and compliance with the vaccination program (Lazarus et al., 2021). We strongly feel that there is an urgent need for health authorities to promote health literacy and build confidence in the public's perception of the vaccine through locally trusted sources of information (Larson et al., 2018), both formally and informally within communities (Lazarus et al., 2021). Finally, our study provides healthcare and government authorities

with the knowledge of healthcare workers' perceptions of the COVID-19 vaccination during the pandemic (Nguyen et al., 2018).

Limitations

We acknowledge certain limitations of the study. First, although this is a modest-sized cohort, this study is cross-sectional, which does not allow the assessment of causality of the different psychological outcomes. Second, questionnaires were self-administered due to the strict infection control measures in all participating institutions. Therefore, the information obtained was not verified by medical personnel. Third, as the measures used were self-reported, this might be subject to reporting bias. It also remains unclear if the study findings are generalizable to the general public given that the healthcare workers' perception and risk profile of the pandemic differ. Therefore, the question of whether current levels of willingness to receive the vaccine are sufficient to achieve community immunity remains unanswered. Nevertheless, it is promising that >95% of high-risk COVID-19 frontline workers are willing to receive the vaccine. However, the COVID-19 vaccine was not yet available to the cohort, so findings focus on intentions rather than behaviors and reporting one's willingness to receive the vaccine may not necessarily be a good predictor of acceptance given that decisions may change over time (Lazarus et al., 2021). In this cohort, >50% of participants expressed willingness to receive other forms of vaccines, including the influenza vaccine, but approximately half of the cohort disagreed that they were intending to/had already been vaccinated against the flu. Regardless, it is important to understand healthcare workers' intentions and perceptions amid this pandemic to enable the successful initiation of the vaccination campaign. Lastly, it is important to note that the key study question asking if subjects were "willing to be vaccinated if the vaccines were safe, available and recommended" might be limited by the dichotomous answer required from participants, as it does not allow for one of the categories to be untrue – e.g., subjects might agree to vaccinate if it were available and recommended but not proven to be safe. However, keeping this in mind, this key question was formulated based on the World Health Organization's recommendations: 1) vaccination safety – many strict protections are in place to ensure the vaccines are safe through multi-stage rigorous testing processes, seeking governmental approval only after they have been proven to be safe and effective; 2) recommendation – after the vaccines have been proven by large (phase III) clinical trials, independent reviews by the Global Advisory Committee on Vaccine Safety, followed by an external panel of experts, namely the Strategic Advisory Group of Experts on Immunization, will then recommend whether the vaccines should be used; 3) availability – following the approvals, the vaccines must be manufactured in large quantities to make the life-saving vaccines readily available to the public (World Health Organization, 2020a). Therefore, this study provides preliminary evidence on willingness to vaccinate after these vaccines have successfully undergone the stringent, mandatory protocol set up by the World Health Organization.

Conclusion

In conclusion, despite many prevailing concerns regarding the COVID-19 vaccine, >95% of healthcare workers in Asia are willing to receive the COVID-19 vaccine. Perceived susceptibility to the pandemic and a pro-socialness mindset are the main drivers for willingness to vaccinate. Strategies are needed to address various psychological components to bolster the overall COVID-19 immunization program.

Conflict of interest

No conflict of interest reported by the authors.

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Ethical approval

Permission to conduct the study was sought from the Zydus Hospitals Ethics Committee (Ref: 2020/12/10).

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