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RESEARCH PAPER

COVID-19 vaccination intention and influencing factors among different occupational risk groups: a cross-sectional study

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ABSTRACT

As an effective measure to manage the Coronavirus disease 2019 (COVID-19) pandemic, the acceptance of the COVID-19 vaccine and understanding the influencing factors of vaccination intention is particularly important. This study aimed to describe the COVID-19 vaccination intention among three different occupational risk groups and identify influencing factors of vaccination intention since a COVID-19 vaccine is available in China. A cross-sectional questionnaire survey was conducted from January 10 to February 5, 2021 in Hangzhou city of Zhejiang Province, an eastern coastal province in China. The intention to accept COVID-19 vaccination and health beliefs based on the Health Belief Model were collected. Of the participants, college students reported the lowest COVID-19 vaccination intention (64.6%), followed by public transportation workers (72.4%) and health care workers (79.9%). Perceived barriers were identified as negative factors of vaccination intention among all three occupational groups. For college students and public transportation workers, perceived benefits and cues to action were identified as protective factors, and cues to action had a positive effect on vaccination intention of health care workers. Tailored interventions are encouraged to reduce barriers of vaccination, improve health beliefs and promote COVID-19 vaccination intentions.

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Introduction

Coronavirus disease 2019 (COVID-19) was declared as a pandemic in March 2020 and has caused more than 100 million infections and 2 million deaths worldwide as of January 2021, leading to a huge burden of disease, death and economy globally.[1,2] As an effective measure to limit viral infection and manage pandemics, a COVID-19 vaccine is regarded as an important prophylactic strategy.[3,4] Many countries around the world have started the COVID-19 vaccination program since a COVID-19 vaccine was already available globally. The COVID-19 vaccines developed by China were approved for marketing conditionally by National Medical Products Administration of China on December 31, 2020, and were gradually introduced to high-risk populations.[5]

Vaccine acceptance is a health issue globally.[6,7] Several previous studies in the United States showed that many Americans were unwilling or unsure to vaccinate the COVID-19 vaccine,[6] and fewer than 70% of Americans were willing to get vaccinated.[1,7] A survey conducted in March 2020, during the COVID-19 pandemic in French, found that 26% of French were reluctant to get vaccinated,[8] compared with 31% in the United Kingdom and 14% in Turkey according to a survey conducted in May 2020.[9] Several studies were also conducted in China between May and July 2020 to examine the COVID-19 vaccination intention of the Chinese public and approximately 20% of the public reported they were unwilling to get vaccinated.[10,11] Most studies on vaccine hesitancy in China attributed vaccine hesitancy to vaccine safety concerns and responses to negative vaccine events.[12] To the best of our knowledge, currently very limited studies on COVID-19 vaccination intention were conducted after COVID-19 vaccines were promoted and used gradually worldwide. As with all vaccines, the COVID-19 vaccine acceptance and influencing factors may change with the availability of vaccines and the situation of the epidemic. Even high-quality vaccines and well-organized vaccination programs may encounter social resistance and fail to achieve the satisfactory results.[13] Take the influenza vaccination as an example, although influenza vaccination was considered to be the most effective approach to prevent influenza, the vaccination rate in China was very low with only 2%.[14] Similarly, whether the intention of public to accept a COVID-19 vaccine changes and what factors affect vaccination intention when a vaccine is available remain unclear. With the gradual promotion of COVID-19 vaccines in China, it becomes important to examine the acceptance of a COVID-19 vaccine and understand the influencing factors of vaccine intention among different occupational risk groups to ensure the vaccination rates because a heterogeneous vaccine promotion approach to different populations is more effective than a homogenized approach.[15,16]

The Health Belief Model (HBM) is one of the most widely used theoretical models to study health behavior including vaccination.[17,18] Perceived susceptibility, perceived severity, perceived benefits, perceived barriers, self-efficacy and cues to action are the main components of the Health Belief Model.[19] Using the theoretical framework of the HBM to study the

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influencing factors of COVID-19 vaccination intention may help to find the focus of vaccination promotion and provide specific suggestions for the future vaccination program. In general, the objectives of this study were (1) to describe the COVID-19 vaccination intention among different occupational risk groups in the context that a COVID-19 vaccine is available; (2) to identify related influencing factors of COVID-19 vaccination intention based on Health Belief Model.

Methods

Study design and participants

This cross-sectional study was conducted using multistage sampling from January 10 to February 5, 2021 in Hangzhou City, Zhejiang Province, China. In the first stage, we conducted expert consultations including 10 experts in the field of public health to divide the general population into three categories (high-risk, moderate-risk and low-risk groups) based on the occupational risk of COVID-19 infection in China. Then one occupational group was selected from each risk group (health care workers, public transportation workers, and college students were, respectively, selected from high-risk, moderate-risk and low-risk groups). The sample size of each group was estimated based on a pilot survey of 180 participants consisting of 100 college students, 50 health care workers and 30 taxi drivers. In the pilot survey, about 65% of college students, 80% of transportation workers, and 75% of health care workers reported they were willing to be vaccinated. A minimum sample size of 350 from the low-risk group, 246 from the moderate-risk group, and 288 from the high-risk group would be required to see a statistically significant relationship of this size given 95% power and a 95% confidence level. In the second stage, participants were recruited face-to-face by investigators in the dormitory areas of universities, the taxi pickup areas at Hangzhou airport, and the inpatient department of hospitals. College students, public transportation drivers and health care workers in the survey areas were intercepted at intervals of three people and invited to participate in this survey. The inclusion criterion was individuals aged between 18 and 59, with occupations meeting the survey requirement and with capability to complete the questionnaire independently. To improve the representativeness of the universities and hospitals surveyed, the survey was conducted in four universities and three hospitals, each with at least 88 and 96 participants, respectively. The participants filled in the electronic questionnaire using mobile phones by scanning the QR code provided by the investigators. For the participants without mobile phones, the investigators provided mobile devices to ensure the investigation could be completed. Participants were informed that the survey was anonymous and voluntary. The informed consent was signed before the investigation began.

Instruments

The questionnaire consisted of 31 items in three sections: (1) sociodemographic characteristics (5 items), (2) COVID-19 vaccination intention (1 item), (3) health beliefs on COVID-19 and COVID-19 vaccination based on the Health Belief Model (25 items).[20,21] Ten independent experts with background in public health reviewed the questionnaire. The pilot survey of 180 participants was conducted to ensure the readability, reliability and validity of the questionnaire. The internal reliability of items was examined and results showed that all 5 subscales of the HBM achieved a satisfactory internal reliability (Cronbach's α ranged from 0.93 to 0.97).

Demographics

Sociodemographic characteristics included age, gender, urbanicity, education level, and monthly household income.

Intention to receive a COVID-19 vaccine

The participants were asked to what extent they agreed with the following statement "I intend to accept COVID-19 vaccine" on a five-point Likert scale ("strongly disagree", "disagree", "neutral", "agree", and "strongly agree"). The "agree" and "strongly agree" responses were recoded to "intend", and the "strongly disagree", "disagree" and "neutral" responses were recoded to "do not intend".

Beliefs surrounding COVID-19 and COVID-19 vaccination

The questions probed perceived susceptibility to COVID-19 infection (four items), perceived severity of COVID-19 infection (four items), perceived benefits of a COVID-19 vaccine (four items), perceived barriers related to a COVID-19 vaccine (eight items) and cues to action (five items) based on previous studies about vaccine hesitancy.[20,21] Participants responded all questions using a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree). The mean score for each subscale of health belief model was calculated.

Ethics approval

This study was approved by The Ethics Committee of the School of Public Health at Zhejiang University (No. ZGL202002-3).

Statistical analysis

All data were analyzed using IBM SPSS Statistics Version 23.0 for Windows and AMOS Version 22.0. Confirmatory factor analysis (CFA) was used to determine the relationships between health belief variables. Descriptive analyses included means for continuous variables and percentages for categorical data. Chi-square tests and Kruskal-Wallis tests were conducted to compare the intention to accept a COVID-19 vaccine between groups and detect the significance of health belief subscales among occupational risk groups. Binary logistic regression analysis was used to examine the association of the independent variables with COVID-19 vaccine intention. Sociodemographic variables including age, gender, urbanicity, education level, and monthly household income were controlled as confounders in the regression model. Odds ratios (OR), 95% confidence intervals (95% CI) and p-values were calculated for each independent variable. All comparisons

were two tailed. The significance threshold was p-value < 0.05.

Results

Demographics

A total of 1,039 participants including 463 college students, 283 public transport workers and 293 health care workers were included for analysis (Table 1). A total of 17 participants refused to participate in this survey during the informed consent phase and the participation rate was 98.4%. Most of participants were female, aged 18 to 29, received college or above education, lived in urban areas, and had a monthly household income below 5,000 China Yuan (CNY).

COVID-19 vaccination intention

Overall, 738 (71.0%) of participants reported an intention to be vaccinated, while 301 (29.0%) reported a rejection or neutral attitude (Table 1). Health care workers reported the highest intention to vaccination (79.9%) followed by public transportation workers (72.4%), while college students showed the lowest intention to vaccinate (64.6%). The results of chi-square test showed that there was significance in vaccination intention among different ages and occupations.

Health beliefs

Confirmatory factor analysis (CFA) was conducted to confirm that HBM factors were being measured appropriately by each item. Two health belief items with factor loading below 0.5 ("I will not be infected after the COVID-19 vaccination" in the perceived benefits subscale and "I worry about the lack of easy access of the COVID-19 vaccine" in the perceived barriers subscale) were excluded and Table 2 showed the satisfactory items with factor loading above 0.5, indicating that the measuring instrument was distinct and identifiable.

On the whole, the participants had low perceptions of susceptibility (Table 2). Fewer than a quarter of participants agreed that getting COVID-19 is possible for them (23.9%) or COVID-19 may outbreak in their living area (23.2%). Fewer than half agreed that contacting with COVID-19 patients or close contacts of COVID-19 patients is possible for them (38.8%) or they may get COVID-19 with good hygiene practices (43.4%). Health care workers had higher scores than average perceived susceptibility. Surprisingly, the perceived susceptibility of public transport workers was the lowest of the three groups.

More than half the participants agreed that they were afraid of getting COVID-19 (52.6%) while less than half agreed they would probably die (35.8%) or became very sick (28.2%) if they got COVID-19. Less than half agreed their financial situation would get worse if they get COVID-19 (42.3%). Health care workers had the lowest scores of perceived severities while the score of public transport workers was the highest.

High perceived benefits of COVID-19 vaccination were reported. The majority of participants agreed vaccination can make them feel more secure (61.9%), reduce the risk of their family getting COVID-19 (70.0%), and benefit from the vaccination (71.9%). Public transport workers had the highest perceived benefits followed by college students, while health care workers scored below average.

Overall, the participants had low perceptions of barriers. The highest barrier perceived by participants was the side effects of the COVID-19 vaccine (47.5%) followed by the worry of virus mutation (46.7%), possible complications (43.6%), vaccine safety (39.6%) and vaccine efficacy (37.2%). Concern about the protection period of vaccines and distrust of vaccines due to negative vaccine events were only 34.2% and 15.4% respectively. Notably, public transport workers and college students scored higher than average for perceived barriers, while health care workers had the lowest scores.

High scores of cues to action were reported by participants. The highest score reported by participants was the government

Table 1. Demographic characteristics of the study population (N = 1,039).

		Intention to take COVID-19 vaccination N (%)			
	Overall	Intend, N = 738	Do not intend, N = 301	χ^2	p-value
Age				13.17	.004
18–29	745(71.7)	510(68.5)	235(31.5)		
30–39	133(12.8)	105(78.9)	28(21.1)		
40–49	107(10.3)	76(71.0)	31(29.0)		
50–59	54(5.2)	47(87.0)	7(13.0)		
Gender				0.580	.452
Male	499(48.0)	360(72.1)	139(27.9)		
Female	540(52.0)	378(70.0)	162(30.0)		
Occupation				20.75	<.001
College students	463(44.6)	299(64.6)	164(35.4)		
Public transportation workers	283(27.2)	205(72.4)	78(27.6)		
Health care workers	293(28.2)	234(79.9)	59(20.1)		
Education level				0.374	.596
Senior high school or less	297(28.6)	215(72.4)	82(27.6)		
College or above	742(71.4)	523(70.5)	219(29.5)		
Urbanicity				0.009	.924
Urban	875(84.2)	621(71.0)	254(29.0)		
Rural	164(15.8)	117(71.3)	47(28.7)		
Monthly household income (CNY)				2.364	.500
<5,000	321(30.9)	237(73.8)	84(26.2)		
5,001–10,000	310(29.8)	217(70.0)	93(30.0)		
10,001–20,000	289(27.8)	198(68.5)	91(31.5)		
>20,000	119(11.5)	86(72.3)	33(27.7)		

Table 2. The distribution and factor loading of health belief items (N = 1,039).

	Total N (%)	College students N (%)	Public transportation workers N (%)	Health care workers N (%)	Kruskal-Wallis test	p-value
Health belief items (Factor loading indicated [a])						
Perceived susceptibility						
Perceived susceptibility score (Mean, SD) [b]	2.88(0.94)	2.91(0.93)	2.78(1.00)	2.95(0.87)	5.846	.054
Getting COVID-19 is possible for me (0.82)	248(23.9)	103(22.2)	72(25.4)	73(24.9)		
Contacting with COVID-19 patients or close contacts of COVID-19 patients is possible for me (0.82)	403(38.8)	164(35.4)	84(29.7)	155(52.9)		
COVID-19 may outbreak in my living area (0.81)	241(23.2)	116(25.1)	64(22.6)	61(20.8)		
Even with good hygiene practices (wearing a mask, etc.), I may still get COVID-19 (0.70)	451(43.4)	221(47.7)	116(41.0)	114(38.9)		
Perceived severity						
Perceived severity score (Mean, SD) [b]	3.11(0.91)	3.11(0.85)	3.26(1.04)	2.98(0.87)	13.73	.001
I am afraid of getting COVID-19 (0.60)	547(52.6)	257(55.5)	159(56.2)	131(44.7)		
I will probably die if I get COVID-19 (0.87)	372(35.8)	167(36.1)	117(41.3)	88(30.0)		
I will be very sick if I get COVID-19 (0.89)	293(28.2)	123(26.6)	106(37.5)	64(21.8)		
My financial situation will get worse if I get COVID-19 (0.63)	439(42.3)	161(34.8)	165(58.3)	113(38.6)		
Perceived benefits						
Perceived benefits score (Mean, SD) [b]	3.74(0.72)	3.75(0.68)	3.82(0.80)	3.66(0.67)	7.363	.025
I can reduce the risk of my family getting COVID-19 after the COVID-19 vaccination (0.66)	727(70.0)	324(70.0)	203(71.7)	200(68.3)		
I will feel more secure in my daily life after the COVID-19 vaccination (0.72)	643(61.9)	294(63.5)	184(65.0)	165(56.3)		
In general, I will benefit after the COVID-19 vaccination (0.88)	747(71.9)	327(70.6)	205(72.4)	215(73.4)		
Perceived barriers						
Perceived barriers score (Mean, SD) [b]	3.21(0.68)	3.27(0.62)	3.29(0.73)	3.04(0.71)	26.35	<.001
I am worried that the COVID-19 vaccine is not effective (0.72)	386(37.2)	183(39.5)	107(37.8)	96(32.8)		
I worry about the safety of the COVID-19 vaccine (0.85)	411(39.6)	207(44.7)	114(40.3)	90(30.7)		
I think the protection period of the COVID-19 vaccine is too short (0.68)	355(34.2)	139(30.0)	116(41.0)	100(34.1)		
I worry about the side effects of the COVID-19 vaccine (0.80)	494(47.5)	247(53.3)	135(47.7)	112(38.2)		
I worry that COVID-19 virus has mutated and vaccines could not work (0.72)	485(46.7)	244(52.7)	130(45.9)	111(37.9)		
I worry about possible complications from the COVID-19 vaccine (0.64)	453(43.6)	215(46.4)	139(49.1)	99(33.8)		
Vaccine safety incidents in the past left me distrusting the COVID-19 vaccine (0.52)	160(15.4)	60(13.0)	75(26.5)	25(8.5)		
Cues to action						
Cues to action score (Mean, SD) [b]	3.67(0.68)	3.56(0.66)	3.73(0.77)	3.80(0.57)	34.43	<.001
My family members recommend me to get the COVID-19 vaccine (0.70)	505(48.6)	172(37.1)	163(57.6)	170(58.0)		
My colleagues/classmates recommend me to get the COVID-19 vaccine (0.73)	483(46.5)	169(36.5)	160(56.5)	154(52.6)		
Health care experts recommend me to get the COVID-19 vaccine (0.86)	707(68.0)	292(63.1)	186(65.7)	229(78.2)		
The government advocates vaccination of the COVID-19 vaccine (0.88)	763(73.4)	312(67.4)	200(70.7)	251(85.7)		
Media advocate vaccination of the COVID-19 vaccine (0.84)	673(64.8)	263(56.8)	186(65.7)	224(76.5)		

[a]All factor loadings are standardized.
[b]The mean score for each HBM variable was calculated and all health belief items used a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

advocacy (73.4%), followed by recommendations from health experts (68.0%) and the media (64.8%). Nearly half of the participants agreed their family members and colleagues or classmates recommended them to get the COVID-19 vaccine. Health care workers had the highest mean scores of cues to action followed by public transport workers, while college students scored below average.

Factors associated with the intention to accept COVID-19 vaccine

Results from the simple logistic regressions showed that older age, higher occupational risk, higher perceived susceptibility, higher perceived severity, higher perceived benefits, higher cues to action were protective factors of accepting COVID-19 vaccine, while higher perceived barriers were risk factors (Table 3).

The results of the multivariable logistic regression showed that after controlling for socio-demographic variables, perceived benefits (aOR = 2.49, 95% CI [1.84–3.36]), perceived barriers (aOR = 0.21, 95% CI [0.15–0.29]) and cues to action (aOR = 5.09, 95% CI [3.52–7.35]) were significant factors of accepting a COVID-19 vaccine.

Table 4 showed the results of the logistic regression on influencing factors of vaccine intention based on three occupational groups. College students with high cues to action (aOR = 5.33, 95% CI [3.15–9.01]) and high perceived benefits (aOR = 2.58, 95% CI [1.69–3.93]) were more likely to have a high acceptance to a COVID-19 vaccine while perceived barriers had a negative effect (aOR = 0.38, 95% CI [0.23–0.62]). For public transportation workers, perceived benefits (aOR = 5.94, 95% CI [2.88–12.28]) and cues to action (aOR = 4.51, 95% CI [2.31–8.80]) were positive factors of accepting a COVID-19 vaccine while perceived barriers were identified as risk factors (aOR = 0.09, 95% CI [0.04–0.21]). For health care workers, cues to action (aOR = 10.50, 95% CI [3.85–28.64]) had a positive influence on vaccination acceptance while perceived barriers played a negative role (aOR = 0.09, 95% CI [0.04–0.20]).

Discussion

To our knowledge, this is the first study described the situation of COVID-19 vaccination intention among different occupational risk groups during the period that COVID-19 was under good control in China and COVID-19 vaccination program had begun worldwide. Factors influencing vaccination intention based on the Health Belief Model were examined among three occupational risk groups. Our study found that college students had the lowest COVID-19 vaccination intention among three occupational groups, followed by public transportation workers and health care workers. For college students and public transportation workers, perceived benefits and cues to action were identified as positive influencing factors of vaccination intention. For health care workers, cues to action had a positive influence on the COVID-19 vaccine acceptance. Perceived barriers were identified as negative factors among three occupational risk groups.

Table 3. Factors associated with the intention to accept COVID-19 vaccine of total participants (N = 1,039).

	Univariate analysis		Multivariable logistic regression	
	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Sociodemographic characteristics				
Gender				
Male	Reference		Reference	
Female	0.90(0.69–1.18)	.447	1.13(0.78–1.65)	.517
Age				
18–29	Reference		Reference	
30–39	1.73(1.11–2.70)	.016	1.42(0.72–2.80)	.318
40–49	1.13(0.72–1.76)	.592	1.25(0.60–2.61)	.552
50–59	3.09(1.38–6.95)	.006	2.70(0.89–8.26)	.081
Occupation				
College students	Reference		Reference	
Public transportation workers	1.44(1.04–1.99)	.026	1.07(0.54–2.12)	.858
Health care workers	2.18(1.54–3.07)	<.001	1.56(1.00–2.42)	.049
Education level				
Senior high school or less	Reference		Reference	
College or above	0.91(0.68–1.23)	.541	1.10(0.62–1.92)	.753
Urbanicity				
Urban	Reference		Reference	
Rural	1.02(0.70–1.47)	.924	1.06(0.67–1.68)	.797
Monthly household Income (CNY)				
<5,000	Reference		Reference	
5,001–10,000	0.83(0.58–1.17)	.284	0.82(0.53–1.26)	.365
10,001–20,000	0.77(0.54–1.10)	.147	0.62(0.39–0.98)	.040
>20,000	0.92(0.58–1.48)	.742	1.24(0.66–2.34)	.506
HBM variables [a]				
Perceived susceptibility	1.36(1.17–1.57)	<.001	1.12(0.89–1.41)	.320
Perceived severity	1.28(1.10–1.48)	.001	1.25(0.99–1.59)	.063
Perceived benefits	3.38(2.70–4.23)	<.001	2.49(1.84–3.36)	<.001
Perceived barriers	0.33(0.26–0.42)	<.001	0.21(0.15–0.29)	<.001
Cues to action	8.64(6.27–11.89)	<.001	5.09(3.52–7.35)	<.001

[a]The mean score for each HBM variable was calculated and all health belief items used a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

Table 4. Factors associated with the intention to accept COVID-19 vaccine among three occupational groups.

	College students (N = 463) Adjusted OR (95% CI)	Public transportation workers (N = 283) Adjusted OR (95% CI)	Health care workers (N = 293) Adjusted OR (95% CI)
Sociodemographic characteristics			
Gender			
Male	Reference	Reference	Reference
Female	1.24(0.76–2.05)	0.60(0.23–1.56)	1.04(0.46–2.35)
Age (years)	1.03(0.96–1.10)	1.01(0.97–1.05)	1.02(0.96–1.07)
Education level			
Senior high school or less	/	Reference	Reference
College or above	/	1.76(0.58–5.37)	0.90(0.25–3.30)
Urbanicity			
Urban	Reference	Reference	Reference
Rural	1.06(0.56–2.01)	0.74(0.31–1.76)	2.37(0.68–8.21)
Monthly household Income (CNY)			
< 5,000	Reference	Reference	Reference
5,001–10,000	0.84(0.46–1.54)	0.79(0.33–1.88)	0.64(0.23–1.77)
10,001–20,000	0.81(0.43–1.54)	0.32(0.12–0.90) *	0.60(0.22–1.65)
> 20,000	1.13(0.51–2.51)	1.18(0.16–8.54)	2.22(0.53–9.35)
HBM variables [a]			
Perceived susceptibility	1.05(0.77–1.44)	0.99(0.62–1.59)	1.21(0.72–2.03)
Perceived severity	1.21(0.85–1.71)	1.55(0.95–2.53)	1.06(0.64–1.76)
Perceived benefits	2.58(1.69–3.93) ***	5.94(2.88–12.28) ***	1.14(0.59–2.20)
Perceived barriers	0.38(0.23–0.62) ***	0.09(0.04–0.21) ***	0.09(0.04–0.20) ***
Cues to action	5.33(3.15–9.01) ***	4.51(2.31–8.80) ***	10.50(3.85–28.64) ***

[a]The mean score for each HBM variable was calculated and all health belief items used a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).
*p < .05; **p < .01; ***p < .001.

We found a relatively higher COVID-19 vaccination intention among health care workers compared with the other two occupational groups. Previous studies showed that the COVID-19 vaccination intention lay between 60% and 90% among physicians in Greece (February 2020),[22] around 72% among healthcare workers in France (October–November 2020),[23] and between 40% and 60% among nurses in Hong Kong, China (February–March 2020).[24] Knowledge about particular vaccines, confidence in efficacy and safety of vaccines were found to be associated with health care workers' intention to vaccinate.[23,25] Our study further revealed that health care workers had the highest scores of cues to action and the lowest perceived barriers. This helps improve our understanding of a better COVID-19 vaccination intention among this sub-group compared with the other two occupational groups.

College students could be considered as potential early adopters of healthy behaviors because they are open-minded, educated, and supposed to respond quickly to public health issues. A study in Italy during the early stage of the COVID-19 pandemic in 2020 reported that 86.1% of college students would accept a future COVID-19 vaccine.[26] However, our study revealed that college students had the lowest intention to accept a COVID-19 vaccine among three occupational groups. One possible reason is that college students may develop an optimistic bias believing that they have a lower risk of infection or risks pose a less serious threat to themselves than to other age groups.[27] In addition, college students had the lowest cues to action score in our study, which may account for their low vaccination intention and should remind health policy makers to attach more importance to provide tailored education messages to this group.

Surprisingly, although public transportation workers had the highest perceived benefits among three occupational groups, this group also had the highest perceived barriers, which may partly explain why their vaccination intention was only slightly higher than that of college students. Efforts are warranted to remove barriers and address their concerns about COVID-19 vaccines.

Furthermore, our study suggested that the participants among all three occupational groups had low perceived susceptibility and perceived severity, which was consistent with the findings of a survey in May 2020 in China.[10] Our results further suggested that this situation was not only true for low-risk individuals, but also for those with higher occupational risk of COVID-19 infection. The cause of the low perceived risk may be associated with good epidemic management and control in China. To be specific, our survey was conducted between January and February, 2021. During the investigation period, there were local outbreaks of COVID-19 in several cities in northern China, but the overall situation was under good control. In Zhejiang province, the number of COVID-19 increased cases was only 1 case during the survey period, which may reduce the risk perception of public. High perceived susceptibility and perceived severity have been proved to be beneficial for adopting protective health behaviors,[28] and accurate public risk perceptions are critical to effectively managing public health risks in a pandemic.[29] Therefore, it is necessary to increase prevention education about improving risk perception for the public.

Our study also showed that the primary concerns in China were the side effects, virus mutation and possible complications caused by COVID-19 vaccine. A previous study in Israel revealed that the most frequently mentioned considerations were the vaccine safety, quality control, potential side effects, and associated COVID-19 illness.[30] Compared with previous studies, our results suggested that along with the negative news about vaccines and the COVID-19 virus mutated worldwide, people seemed to be more concerned about side effects and

virus mutation rather than the efficacy, safety or duration of vaccines. These identified major barriers of COVID-19 vaccine intention should to be paid attention to and related knowledge should be further spread. In addition, although the past negative vaccine events had little impact on confidence of people toward COVID-19 vaccine, which was consistent with previous research on COVID-19 vaccine hesitancy,[10] our survey showed that public transportation workers reported a relatively high level of concern. More vaccine campaigns should be encouraged to address the above crucial concerns of different populations.

A positive highlight of this study was that we found participants among all three occupational groups scored very high on the perceived benefits and cues to action, which were protective influencing factors of vaccination intention. In particular, being able to protect family members from infection was a perceived benefit that most participants agreed on. In addition, we found that the recommendations of medical experts, the advocacy from government and media were widely accepted by participants, suggesting that the promotion of COVID-19 vaccine from these perspectives may be effective.

There are some limitations of this study. First, this is a cross-sectional study, so it can not verify the causal relationship. Second, the research data relies on the self-reporting of survey participants and their responses regarding COVID-19 vaccine intention may be biased due to social desirability.[31] Third, although occupations were stratified according to the level of COVID-19 infection risk in this study, there may still be differences among occupations with the same risk, and the selected study groups may not represent the situation of all the risk groups. Fourth, this study was conducted in Hangzhou City, Zhejiang Province. Although the regional factor was not the focus of this study, it may not be representative of the national situation, and its extrapolation was limited. Finally, we only focused on the vaccination intention of participants aged 18 to 59, and the older adults were not included. Further studies with more occupational groups and all age groups are recommended to broaden the representativeness of the study.

Conclusion

Our study found that college students had the lowest COVID-19 vaccination intention, followed by public transportation workers and health care workers. Perceived barriers were negative factors of vaccination intention among all three occupational groups. For college students and public transportation workers, perceived benefits and cues to action were protective factors, and cues to action had a positive effect on vaccination intention of health care workers. Considering that it will be still a long time before COVID-19 is effectively controlled globally, tailored interventions are encouraged to improve the risk perceptions and reduce perceived barriers among different occupational groups to promote COVID-19 vaccination intentions.

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Contributors

TJ and HZ made substantial contributions to the study design and supervised the data collection. HW, SD, HA, XZ and MW contributed to the data collection and interpretation. TJ wrote the substantial parts of manuscript. XZ commented on manuscript. All authors critically revised, reviewed, and approved the final version the manuscript.

Disclosure of potential conflicts of interest

The authors declare no conflict of interest.

Data sharing statement

Data are available from the corresponding author on reasonable request.

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