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Acceptance of the COVID-19 vaccine based on the health belief model: A population-based survey in Hong Kong

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ABSTRACT

Background: Vaccines for COVID-19 are anticipated to be available by 2021. Vaccine uptake rate is a crucial determinant for herd immunity. We examined factors associated with acceptance of vaccine based on (1). constructs of the Health Belief Model (HBM), (2). trust in the healthcare system, new vaccine platforms and manufacturers, and (3). self-reported health outcomes.
Methods: A population-based, random telephone survey was performed during the peak of the third wave of COVID-19 outbreak (27/07/2020 to 27/08/2020) in Hong Kong. All adults aged ≥ 18 years were eligible. The survey included sociodemographic details; self-report health conditions; trust scales; and self-reported health outcomes. Multivariable regression analyses were applied to examine independent associations. The primary outcome is the acceptance of the COVID-19 vaccine.
Results: We conducted 1200 successful telephone interviews (response rate 55%). The overall vaccine acceptance rate after adjustment for population distribution was 37.2% (95% C.I. 34.5–39.9%). The projected acceptance rates exhibited a "J-shaped" pattern with age, with higher rates among young adults (18–24 years), then increased linearly with age. Multivariable regression analyses revealed that perceived severity, perceived benefits of the vaccine, cues to action, self-reported health outcomes, and trust in healthcare system or vaccine manufacturers were positive correlates of acceptance; whilst perceived access barriers and harm were negative correlates. Remarkably, perceived susceptibility to infection carried no significant association, whereas recommendation from Government (aOR = 10.2, 95% C.I. 6.54 to 15.9, p < 0.001) was as the strongest driving factor for acceptance. Other key obstacles of acceptance included lack of confidence on newer vaccine platforms (43.4%) and manufacturers without track record (52.2%), which are of particular relevance to the current context.
Conclusions: Governmental recommendation is an important driver, whereas perceived susceptibility is not associated with acceptance of COVID-19 vaccine. These HBM constructs and independent predictors inform evidence-based formulation and implementation of vaccination strategies.

1. Introduction

Since its emergence in December 2019, the coronavirus disease 2019 (COVID-19) has spread worldwide and became a pandemic of international concern. COVID-19 has induced an unprecedented global burden on health and economy. As of 29 November 2020,

it has led to greater than 1.4 million deaths in 220 countries or territories [1]. While it appears that the whole world is looking forward to the arrival of a safe and effective vaccine, the acceptance for COVID-19 vaccine by general public remains uncertain [2].

Thus far, at least 48 vaccines are in clinical evaluation [3]. COVID-19 vaccines in the pipe line can be divided into two categories. The newer or genetic vaccines include messenger RNA, DNA and non-replicating viral vectors, which are running faster in their speed in clinical evaluation. There are currently three vaccines showing promise in their efficacy in late-stage clinical trials [4], with two using the newer mRNA technology. However, vaccines from such "newer" platforms have not been approved for

large-scale human use, putting future vaccination campaign at risk of "vaccine hesitancy" [5]. Facing the huge demand in vaccine doses, manufacturers who had not been engaged in vaccine production are now involved. Furthermore, the Governments have been criticised as being limited in capacity for global health security and too slow in response to pandemic. A worldwide decline in public trust in immunisation and the rise of vaccine hesitancy may further impact on vaccine uptake [6,7].

It has been estimated that an uptake of 55–82% is required to achieve herd immunity against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [8]. Therefore, identifying factors associated with acceptance of COVID-19 vaccine is urgently needed to formulate contextual-specific education and policy implementation. The Health Belief Model (HBM) has been adopted as a conceptual framework that was extensively evaluated empirically [9]. It empowers researchers to explain and predict health promoting behaviour in terms of patterns of belief by addressing the association between health behaviours and health services utilisation [10]. The HBM has previously been used to evaluate beliefs and attitudes toward seasonal influenza and pandemic swine flu vaccines [11,12], as well as the relationship between perceptions and self-paid hepatitis B vaccination [13]. Nevertheless, few studies have examined the various constructs of the HBM that could predict the acceptance of COVID-19 vaccine, although there are studies that have examined the acceptance of and willingness to pay for the COVID-19 vaccine in the Asia Pacific region [14–17]. In addition, recent studies showed that trust in the healthcare system and vaccine manufacturing is a crucial component of health education programmes that target to promote life-saving vaccines [18]. Regular assessment and surveillance of trust levels with a focus on deliberate initiatives to establish trust in immunisation programmes represent important steps to narrowing vaccine confidence gaps [18].

The objectives of this study were to evaluate the acceptance of COVID-19 vaccine in the general population of Hong Kong, and examined the factors independently associated with willingness. In particular, we hypothesised that the HBM constructs and level of trust towards the healthcare system and/or vaccine manufacturers are significantly associated with the acceptance of an individual to COVID-19 vaccine.

2. Methods

2.1. Study design and setting

We adopted a methodology similar to a previous population-based, random telephone survey conducted in Hong Kong [19]. All Chinese individuals aged ≥ 18 years who could communicate in Chinese are eligible to participate. Telephone numbers were first selected randomly from an updated directory as seed numbers to minimise sampling error. The updated directory was composed according to an online website which documented the landline telephone numbers from Hong Kong residents in 2018 by a telephone company, which covers all the Hong Kong telephone landlines. Another three set of numbers were then generated through randomisation of the last 2 digitals in order to recruit the unlisted numbers. Duplicate numbers were screened out, with the remaining numbers mixed in a random order to form the final sample. The selection of the sample population was conducted by the Centre for Health Behaviours Research of the Chinese University of Hong Kong. Since a minority of family households had more than one fixed telephone line, participants were asked if they have already been recruited to avoid double counting. If there was no response in the initial telephone call, at least three attempts in separate occasions were given. All telephone calls to each household for

non-respondents were separated by at least one day. If the target subject was available but busy to complete interview, a mutually convenient time was scheduled to administer the survey. According to standard methodology, only one subject was recruited from each household to avoid clustering effect within household. Upon successful contact with a target household, one qualified household member was selected using the last birthday random selection method (i.e. a respondent aged ≥ 18 years in a household who just had his/her birthday was selected to participate), which has been used in a previous territory-wide telephone survey in Hong Kong [20]. Non-response was defined as non-completion of the survey after three telephone attempts. Non-respondents were replaced by the next household telephone number. Interviews were carried out between 17:00 and 22:00 on weekdays and other periods including weekends and public holidays should appointments with suitable subjects were arranged. The interviewed subjects were briefed about the study purpose, assured of the confidentiality, and requested to provide informed consent. The centre trained a team of interviewers on the administration of telephone interviews by experienced epidemiologists, and interviews were performed using a fieldwork manual highlighting standard operation procedure. An experienced project coordinator supervised the research team throughout the study, and was responsible for administering quality assurance for the telephone interviews. The telephone interviews were performed from 27 July to 27 August 2020 when Hong Kong faced the peak of the third wave of COVID-19. At that time, social distancing measures were escalated including work from home, limiting public gatherings to two people, banning restaurant eating-in, and reinforcing compulsory wearing of face masks in public places [21]. Assuming the proportion of COVID vaccine acceptance as 50%, a minimum of 1111 subjects were required to achieve a precision level of 3% from the formula: "[precision = $1.96 \times \sqrt{[(p) \times (1-p)/N]}$". The study was approved by the Survey and Behavioural Research Ethics Committee (SBREC) of the Chinese University of Hong Kong.

2.2. Survey instrument

A questionnaire based on the HBM previously designed and developed by a panel of epidemiologists, psychologists, and clinicians was used (Supplementary Document) [19]. Acceptance in this study was defined as the action of consenting to receive or undertake the CVOID-19 vaccine. It was assessed by the responses to the question: "If the Government will provide a free-of-charge COVID-19 vaccine within the next 12 months, will you receive it?" with response options "yes", "no", or "not sure". The survey consisted of four sections including (1) sociodemographic details (age, gender, marital status, educational level, job status, household income, utilisation of social security allowance); (2) self-reported health status (measured by the presence of chronic conditions and the self-report health-related quality of life [HRQoL]); (3) perception, attitude and acceptance of COVID-19 vaccine, and (4) trust towards the healthcare system, new vaccine platforms and manufacturers. The variables pertinent to the HBM about the COVID-19 vaccine were used, including perceived susceptibility (which was defined as the subjective assessment of the risk of contracting COVID-19 measured by 3 items); perceived severity (severity and consequences of having COVID-19 by 4 items); perceived benefits (value or efficacy of receiving COVID-19 vaccine by 4 items), perceived barriers (obstacles to receive COVID-19 vaccine by 4 items); and clues to actions (triggers for receiving COVD-19 vaccination by 4 items, including recommendations by the Government, physicians, family members and friends, respectively). Two scales were used to measure trust in the survey [18,22]. The first scale assessed the degree of trust of an individual towards the healthcare system (3 items). This scale reflects overall beliefs about one's willingness

to be placed into the healthcare system in general. Trust in manufacturers was measured via a modified 4-item scale developed and validated by Hall et al. and O'Mallet et al. [23–25]. The participants were asked in a Likert scale how strongly they agreed or disagreed with each statement asking on trust in various dimensions. Higher scores indicate greater trust. The self-reported chronic condition was defined as whether the respondents had long-term medical follow up or chronic medication. The self-reported HRQoL was measured by using the culturally validated Hong Kong Chinese scale of EQ-5D-5L instrument (EQ-5D-5L HK) [26–28]. The scale consists of a five-dimension descriptive system for self-reported health status (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression). Each dimension has five response levels describing the health status with a level of severity (1 = problem, 2 = slight, 3 = moderate, 4 = severe and 5 = unable/extreme problems). In addition, the single preference-based health index (utility scores, ranged 0–1) was derived from the collective responses of the five dimensions on self-reported health status according to the Hong Kong population tariff to reflect the self-reported HRQoL.

2.3. Data analysis

Data analysis was performed by the Statistical Package for Social Sciences (SPSS) version 20 (IBM). The primary outcome variable was a dichotomous variable on acceptance of COVID-19 vaccination. Univariate analysis was based on Pearson's chi-square tests. Multivariable regression analysis was conducted with vaccine acceptance as the outcome variable whilst controlling for the above covariates with p values < 0.20 in univariate analysis. We tested for variable interaction among all potential independent variables using product terms, and found that there was a significant interaction between the HBM constructs and the trust scales. Hence, we performed three independent binary logistic regression analyses with (1). trust scale excluded; (2). HBM variables excluded; and (3). trust scale and HBM variables excluded, but included the four components of clues to action (recommendations by the Government, physicians, family members and friends, respectively). All p values < 0.05 were considered statistically significant. This study was approved by the Survey and Behavioural Research Ethics Committee of the Chinese University of Hong Kong (Reference No. SBRE-19-796).

3. Results

3.1. Participant characteristics

The response rate to our telephone interview was 55%, and 1200 successful interviews were completed. (Supplementary Table 1). The total number of call attempts was 21,256. The majority were aged ≥ 55 years (68.6%), and female participants consist of 71.4% of the sample (Table 1). Among them, 77.5% were married, and most had received educational below or at secondary level (76.4%). Around 31% was receiving old age allowance, and most were retired (35.8%) or housewives (34.6%).

3.2. Acceptance of COVID-19 vaccine

Overall, 42.2% of study participants indicated acceptance of COVID-19 vaccine, whilst 17.4% expressed unwillingness, and 40.4% indicated not sure. Age, but not sex, showed a significant association with acceptance [univariate analysis, p < 0.01]. After a set of weighed adjustments according to the actual age structure of the Hong Kong population, we projected that the overall COVID-19 vaccine acceptance rate for Hong Kong adults (≥18 years) was

37.2% (95% C.I. 34.5–39.9%) (Supplementary Table 2). The projected acceptance rates exhibited a J-shape with age, with higher acceptance (40.4%, 95% C.I. 32.3–49.0%) among the younger generation aged 18–24 years than individuals aged 25–34 years (24.4%), and then a linear increase with age reaching 47.6% (95% C.I. 41.3–54.2%) among subjects aged ≥ 65 years (Fig. 1) .

In addition to traditional variables for vaccine acceptance, our survey covered a few key variables that are relevant to the current context of COVID-19 vaccine production (Table 1). We found a substantial proportion of the respondents did not feel confident on vaccines produced by manufacturers without experience of large-scale vaccine production (52.2%); developed using new platforms (43.3%); or tested in clinical trials with <50,000 people (32.5%). A significant proportion of the participants considered the country where the vaccine was produced would affect their confidence level (37.4%). Also, 62.5% indicated that the country where vaccine was produced would influence their acceptance, and 67.2% agreed that if the vaccine has been tested in < 50,000 people, their acceptance of the vaccine would be reduced (Fig. 3).

3.3. Factors associated with acceptance of COVID-19 vaccine

From univariate analysis (Table 2), older age (≥65 years), educational attainment at primary level or below, receipt of old age or disability allowance, retirement, and the presence of self-reported health status (having chronic medication and poorer HRQoL) were associated with higher acceptance of COVID-19 vaccine. Respondents who perceived higher susceptibility to COVID-19 infection, perceived higher severity of COVID-19 to their own health, perceived greater benefits of vaccine, and received cues to action were significantly more likely to indicate vaccine acceptance (Table 2). Participants who perceived higher access barriers to receiving the vaccine and greater harm of the vaccine were less likely to express acceptance. Trust in the healthcare system and the vaccine manufacturer were positively associated with vaccine acceptance.

In multivariable regression analysis without the trust scale (**Model 1**), perceived severity (adjusted odds ratio [aOR] 1.16, 95% C.I. 1.01 to 1.32, p = 0.037), perceived benefits of the vaccine (aOR 1.22, 95% C.I. 1.01 to 1.48, p = 0.037), and more cues to action (aOR 2.61, 95% C.I. 2.32 to 2.94, p < 0.001) remained to be positive correlates of vaccine acceptance; whilst perceived access barriers (aOR 0.80, 95% C.I. 0.68 to 0.94, p = 0.007) and perceived harm (aOR 0.77, 95% C.I. 0.64 to 0.94, p = 0.008) maintained to be negative factors associated with acceptance. When cues to action was analysed independent of other HBM constructs (**Model 2**), recommendations from the Government (aOR 10.2, 95% C.I. 6.54 to 15.9, p < 0.001), physicians (aOR 2.06, 95% C.I. 1.37 to 3.09, p < 0.001) and family members (aOR 2.07, 95% C.I. 1.36 to 3.16, p = 0.001) were significantly associated with higher vaccine acceptance. In regression models without HBM constructs (**Model 3**), the presence of chronic conditions (adjusted odds ratio [aOR] 1.45, 95% C.I. 1.04 to 2.03. p = 0.030) as well as trust in the healthcare system (aOR 1.30, 95% C.I. 1.17 to 1.45, p < 0.001) and vaccine manufacturers (aOR 1.69, 95% C.I. 1.56 to 1.83, p < 0.001) were positively associated with the COVID-19 vaccine acceptance (See Fig. 2 and Table 3).

4. Discussion

From this telephone survey of the general public of Hong Kong, we found that 42.2% of the respondents indicated acceptance of COVID-19 vaccine, corresponding to a projected acceptance of 37.3% among the whole adult population in Hong Kong. The age-acceptance curve exhibited a J shape showing higher acceptance

Table 1
Participant characteristics (N = 1200).

Demographic	Willing to accept COVID-19 vaccine					
	All		Yes		No/Not sure	
	n	%	n	%	n	%
Total	1200	100.0	507	42.2	693	57.8
Age (years)						
18–24	71	5.9	29	5.7	42	6.1
25–34	68	5.7	17	3.4	51	7.4
35–44	112	9.3	33	6.5	79	11.4
45–54	124	10.3	46	9.1	78	11.3
55–64	261	21.8	110	21.7	151	21.8
≥ 65	562	46.8	271	53.5	291	42.0
Refused to answer	2	0.2	1	0.2	1	0.1
Gender						
Male	344	28.7	146	28.8	198	28.6
Female	856	71.3	361	71.2	495	71.4
Marital status						
Unmarried	183	15.3	65	12.8	118	17.0
Married	930	77.5	401	79.1	529	76.3
Divorce	5	0.4	2	0.4	3	0.4
Widow	75	6.3	36	7.1	39	5.6
Refused to answer	7	0.6	3	0.6	4	0.6
Educational level						
Primary or below	442	36.8	214	42.2	228	32.9
Secondary	474	39.5	187	36.9	287	41.4
Tertiary or above	275	22.9	104	20.5	171	24.7
Refused to answer	9	0.8	2	0.4	7	1.0
Public allowance						
CSSA	25	2.1	12	2.4	13	1.9
Old age and disability allowance	377	31.5	195	38.5	182	26.2
None	795	66.3	300	59.2	495	71.4
Refused to answer	3	0.3	0	0.0	3	0.4
Residential district						
Hong Kong Island	205	17.1	91	18.0	114	16.5
Kowloon East	194	16.2	92	18.2	102	14.7
Kowloon West	191	15.9	76	15.0	115	16.6
New Territories East	230	19.2	98	19.3	132	19.1
New Territories West	315	26.3	139	27.4	176	25.4
Refused to answer	65	5.4	11	2.2	54	7.8
Job status						
Student	51	4.3	23	4.6	28	4.0
Unemployed	36	3.0	8	1.6	28	4.0
Retired	428	35.7	205	40.5	223	32.2
Housewife	415	34.6	167	33.0	248	35.8
Medical or healthcare	9	0.8	2	0.4	7	1.0
Restaurant	8	0.7	4	0.8	4	0.6
Public transport driver	11	0.9	5	1.0	6	0.9
Others	207	17.3	81	16.0	126	18.2
Refused to answer, but employed	31	2.6	9	1.8	22	3.2
Refused to answer but not employed	3	0.3	2	0.4	1	0.1
Chronic conditions[*]						
No	581	48.4	200	39.5	381	55.0
Yes	617	51.4	307	60.6	310	44.7
Refuse to answer	2	0.0	0	0.0	2	0.3
Self-reported Health Status HRQoL – Utility index (Mean; S.D.)	0.946 (0.124)		0.937 (0.134)		0.952 (0.116)	

CSSA, Comprehensive Social Security Assistance; HRQoL: Health Related Quality of Life.
[*] Chronic conditions was defined as whether having chronic medication or long-term medical follow-up.

among young adults, then increased gradually with age. We also identified several independent factors associated with acceptance, including the presence of chronic conditions, five out of six constructs of the HBM, trust in the healthcare system and the vaccine manufacturers, as well as the quality of life of the respondents. Recommendation of COVID-19 vaccination by the government was the strongest factor (aOR 10.2), whereas perceived susceptibility to infection was not associated with vaccine acceptance.

Despite our surveillance being conducted at the peak of the third COVID-19 wave in Hong Kong when the record high daily confirmed cases was reported, our proportion of COVID-19 vaccine acceptance (42.2% of respondents, and 37.2% for whole adult population after adjustment) was far lower than those of other countries [5,27–32]. One possible explanation of the low acceptance could be due to a substantial proportion of respondents who expressed doubt about vaccines based on the newer genetic platforms, and yet these newer vaccines are now in the front end of clinical trial. Of note, our survey was conducted before the announcement of holding up a COVID-19 vaccine clinical trial due to the report of an adverse event. Other worries impacting acceptance as expressed by a significant number of study participants included the track record of manufacturers on massive
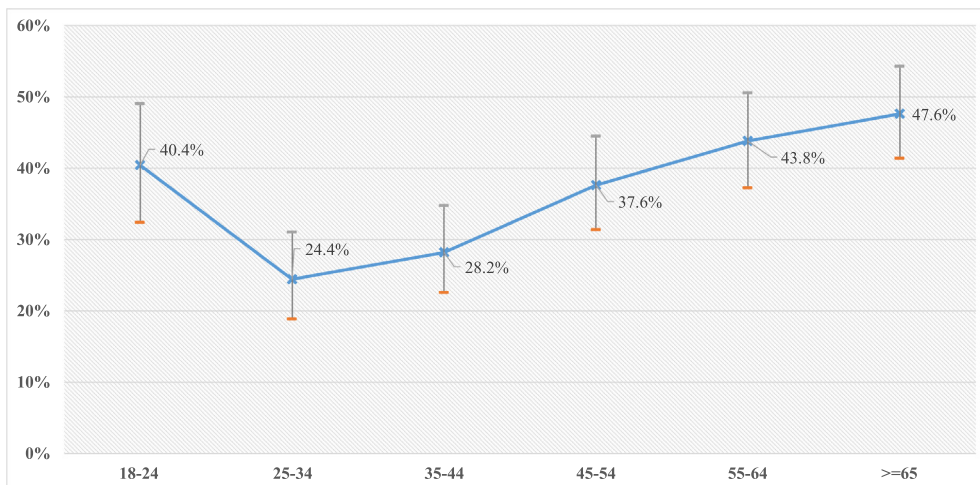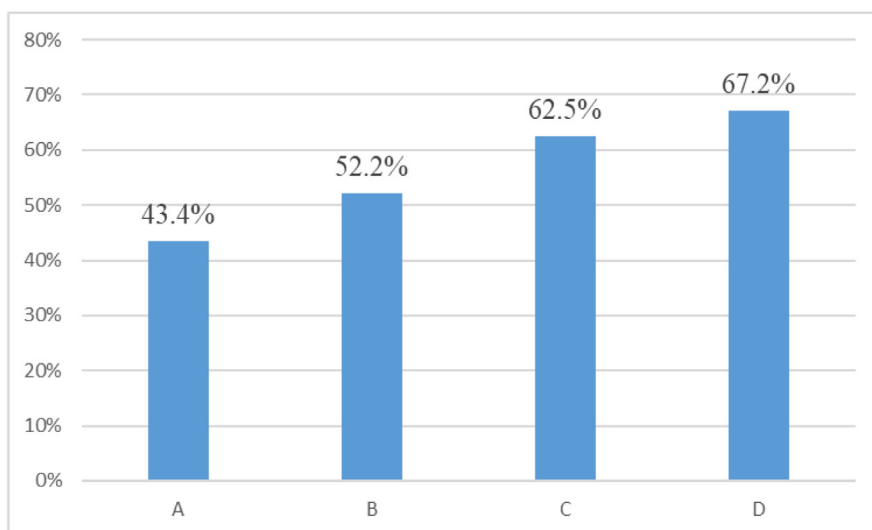
Fig. 1. Projected prevalence of willingness to accept COVID-19 vaccine (%) by age groups (years) in the Hong Kong adult population.

A: Proportion of participants who expressed unwillingness to accept vaccines produced by "newer" platforms based on the "genetic" approach

B: Proportion of participants who indicated unwilling to accept vaccine from manufacturers without previous track record on vaccine production

C: Proportion of participants who indicated that the country where vaccine was produced would influence their willingness

D: Proportion of participants who agreed that if the vaccine has been tested in less than 50,000 people, their acceptability of the vaccine would be reduced

Fig. 3. The perception of survey respondents to vaccine manufacturers and vaccine production.

vaccine production as well as the unacceptability of vaccines produced based on small-scale clinical trials and their uncertainty about the country where the new COVID-19 vaccine will be produced. While these contemporary issues of COVID-19 vaccines have not been addressed in previous studies, our findings urge a need to address them, and any wrong information and misunderstandings should be clarified before launching vaccination campaign.

We found that elderly individuals had higher acceptance of the COVID-19 vaccine. This finding is consistent with results from previous studies [30,31]. One might argue that elderly individuals, especially after their retirement, are in general more health-conscious and are having a higher risk of contracting more serious disease and death due to COVID-19 [33]. This may also account for our finding that people with chronic conditions were significantly more likely to express vaccine acceptance. This observation reas-

sures the current policy to regard these individuals as a top priority group to receive COVID-19 vaccine [33]. The higher level of vaccine acceptance among the youngest adult group aged 18–24 years could be attributed to most being students, who have better exposure to vaccine education and received free vaccines since they were born [34]. As a result, they may have a better impression on vaccination when compared with other age groups.

Most of the HBM constructs were found to be significantly associated with vaccine acceptance. In particular, respondents who perceived COVID-19 as serious, the vaccine as conferring benefits, and received cues to action were significantly more likely to accept the vaccine. On the other hand, the perception of access barriers and potential harm induced by the vaccine were negatively associated with their acceptance. Similar HBM outcomes were also found in a study performed in Malaysia, and in addition, they found that the public value the efficacy and safety of vaccines more than the

Table 2
Factors associated with acceptance of COVID-19 vaccine by univariate analysis.

Factors	n	Vaccine acceptance %	COR	95% CI		p
Age						
18–44	251	31.5	Reference			
45–64	385	40.5	1.48	1.06	2.07	0.021
≥65	562	48.2	2.03	1.48	2.77	<0.001
Sex						
Male	344	42.2	Reference			
Female	856	42.4	1.01	0.79	1.30	0.932
Marital status						
Unmarried	183	35.5	Reference			
Married	930	43.1	1.38	0.99	1.91	0.057
Widowed or divorced	80	47.5	1.64	0.96	2.80	0.068
Educational level						
Primary or below	442	48.4	Reference			
Secondary	474	39.5	0.69	0.54	0.90	0.006
Tertiary or above	275	37.8	0.65	0.48	0.88	0.006
Public allowance						
None	795	37.7	Reference			
CSSA	25	48.0	1.52	0.69	3.38	0.301
Old age and disability allowance	377	51.7	1.77	1.38	2.27	<0.001
Residential district						
Hong Kong Island	205	44.4	Reference			
Kowloon East	194	47.4	1.30	0.62	2.71	0.489
Kowloon West	191	39.8	0.94	0.34	2.58	0.901
New Territories East	230	42.6	1.40	0.53	3.67	0.494
New Territories West	315	44.1	1.31	0.58	2.95	0.511
Job status						
Employed	267	38.2	Reference			
Housewife	415	40.2	1.09	0.80	1.49	0.595
Retired	428	47.9	1.49	1.09	2.03	0.012
Chronic conditions[*]						
No	581	34.4	Reference			
Yes	617	49.8	1.89	1.50	2.38	<0.001
Self-reported HRQoL						
Health Index			0.39	0.15	1.97	0.043
HBM						
Perceived susceptibility			1.09	1.00	1.17	0.039
Perceived severity			1.11	1.04	1.17	0.001
Perceived benefits			1.79	1.59	1.99	<0.001
Perceived access barriers			0.91	0.83	0.99	0.023
Perceived harm			0.71	0.64	0.79	<0.001
Cues to action			2.76	2.48	3.08	<0.001
Trust						
Trust in health system			1.36	1.25	1.48	<0.001
Trust in manufacturer			1.71	1.58	1.85	<0.001

COR, crude odds ratio; CI, confidence interval; CSSA, Comprehensive Social Security Assistance (CSSA) Scheme; HBM, health belief model; HRQoL: Health Related Quality of Life.
[*] Chronic conditions were defined as whether having long-term medical follow-up a chronic medication.

cost of the vaccines [32]. These findings suggested that the constructs of HBM could be used to explain vaccine uptake behaviour, as in previous studies demonstrating the capability of the HBM constructs in predicting behaviours related to influenza vaccination [35].

While cues to action is an important element of HBM and they were found to be a significant driving force of vaccine acceptance, we found a remarkable pattern for COVID-19 vaccine. The recommendation from the government stood out as the most important cue, far stronger than others, such as those from doctors and family members. Therefore, instead of leaving the decision to individuals or their doctors, governmental should make a clear stand. Furthermore, another common driver for adult vaccines, peer group, also did not turn out to be an important driver. These observations provide evidence-based design of vaccine promotion campaigns tailored for the context of the population concern.

Trust in vaccination contributes to explain vaccination uptake [36]. Owing to the huge demand of COVID 19 vaccine, a lot of

new manufacturers entered the market [37]. However, because of the lack of knowledge and too many manufacturers all come at once, it is more likely for potential vaccine recipients to doubt the legitimacy of less well known manufacturers, which could in turn lower their vaccine acceptance. Government should also proactively provide information about their selected vaccine manufacturer(s) to break this barrier.

Of note, we found that a key component of HBM perceived susceptibility to infection was not associated with acceptance. This observation could be explained by the fact that COVID-19 is perceived as a mild disease unless the infected person has underlying at risk conditions. This implies the direction of promotion and education for COVID-19 vaccine might have to be different from other vaccines in which prevention of infection is perceived as the main purpose. Rather, perceived severity being a significant factor should be a focus for vaccine campaigns.

This is the first representative population-based study in Hong Kong that examined the association between the constructs of
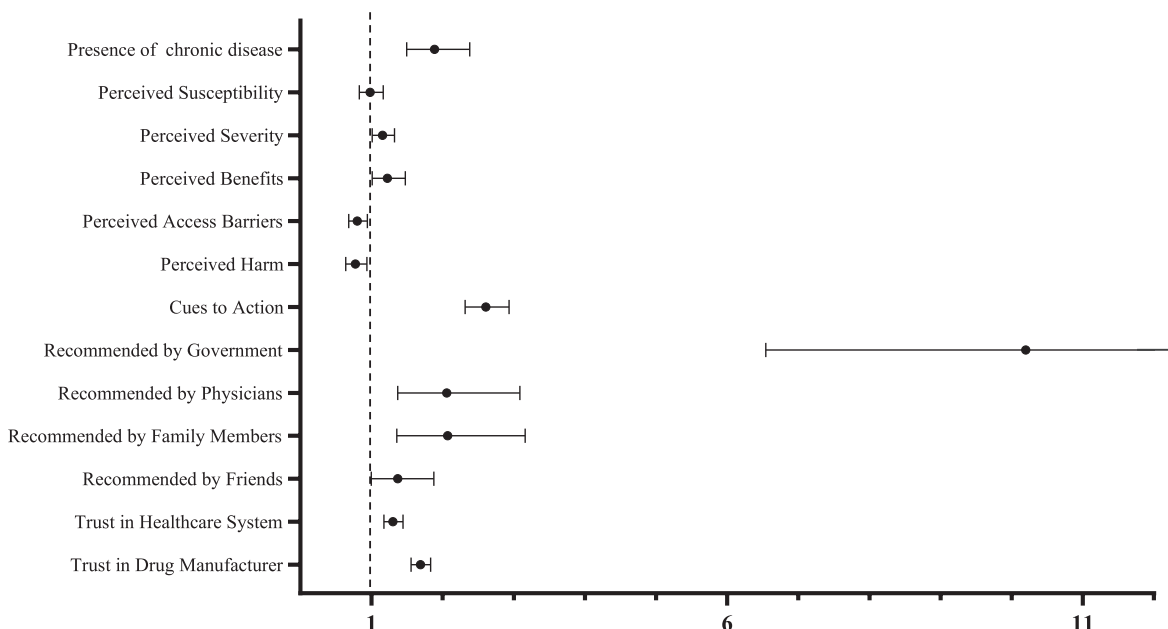
Fig. 2. Adjusted odds ratios and 95% confidence intervals in multivariate analysis of key factors for acceptance of COVID-19 Vaccine.

Table 3
Factors associated with acceptance of COVID-19 vaccine by multivariate logistic regression.

Factors	n	Acceptance %	Model 1 AOR	95% CI		p	Model 2 AOR	95% CI		p	Model 3 AOR	95% CI		p
Age														
18–44	251	31.5	Reference				Reference				Reference			
45–64	385	40.5	1.66	0.86	3.20	0.131	1.43	0.75	2.72	0.277	1.13	0.71	1.81	0.601
≥ 65	562	48.2	1.84	0.74	4.57	0.188	1.92	0.80	4.61	0.145	1.04	0.56	1.91	0.910
Marital status														
Unmarried	183	35.5	Reference				Reference				Reference			
Married	930	43.1	1.38	0.71	2.70	0.342	1.41	0.74	2.70	0.300	1.03	0.63	1.69	0.893
Widowed or divorced	80	47.5	1.62	0.57	4.60	0.364	1.30	0.48	3.55	0.604	0.92	0.44	1.89	0.812
Educational level														
Primary or below	442	48.4	Reference				Reference				Reference			
Secondary	474	39.5	0.92	0.55	1.55	0.758	0.91	0.55	1.51	0.722	0.98	0.69	1.39	0.908
Tertiary or above	275	37.8	1.19	0.60	2.36	0.616	1.13	0.58	2.18	0.724	1.18	0.74	1.88	0.491
Public allowance														
None	795	37.7	Reference				Reference				Reference			
CSSA	25	48.0	0.50	0.09	2.76	0.430	0.34	0.07	1.66	0.181	0.78	0.28	2.18	0.641
Old age and disability allowance	377	51.7	0.86	0.47	1.59	0.635	0.76	0.41	1.39	0.369	1.22	0.80	1.84	0.357
Job status														
Employed	267	38.2	Reference			0.333	Reference				Reference			
Housewife	415	40.2	0.73	0.38	1.39	0.333	0.93	0.50	1.71	0.821	0.70	0.45	1.09	0.111
Retired	428	47.9	0.89	0.44	1.83	0.754	1.18	0.60	2.33	0.640	0.70	0.43	1.15	0.158
Chronic conditions														
No	581	34.4	Reference				Reference				Reference			
Yes	617	49.8	1.15	0.70	1.88	0.586	1.06	0.65	1.72	0.817	1.45	1.04	2.03	**0.030**
Self-reported HRQoL														
Health index			1.19	0.22	6.31	0.843	1.02	0.20	5.15	0.981	1.59	0.48	5.28	0.449
HBM														
Perceived susceptibility			0.98	0.83	1.17	0.839								
Perceived severity			1.16	1.01	1.32	**0.037**								
Perceived benefits			1.22	1.01	1.48	**0.037**								
Perceived access barriers			0.80	0.68	0.94	**0.007**								
Perceived harm			0.77	0.64	0.94	**0.008**								
Cues to action			2.61	2.32	2.94	**<0.001**								
Government							10.20	6.54	15.88	**<0.001**				
Physicians							2.06	1.37	3.09	**<0.001**				
Family members							2.07	1.36	3.16	**0.001**				
Friends							1.37	1.00	1.88	0.052				
Trust														
Trust in healthcare system											1.30	1.17	1.45	**<0.001**
Trust in drug manufacturer											1.69	1.56	1.83	**<0.001**

AOR, adjusted odds ratio; CI, confidence interval; CSSA, Comprehensive Social Security Assistance; HBM, health belief model; HRQoL: Health Related Quality of Life.
Model 1: All covariates except the two trust scales were included in the analysis;
Model 2: All covariates except the two trust scales and the HBM constructs were included in the analysis, with an additional variable of cues to action from different sources
Model 3: All covariates except the HBM constructs were included in the analysis.

HBM, the level of trust to relevant stakeholders, and the acceptance of COVID-19 vaccine. It has a high response rate based on a random sampling strategy, and the survey instrument was validated by an expert panel. There are, nevertheless, several limitations that should be addressed. Firstly, this is a cross-sectional survey and we could not establish a cause-and-effect relationship between the independent factors and the outcome. They could however be used in prediction of COVID-19 vaccine acceptance. Also, this survey examined the HMB constructs and trust scales in a Chinese population, and the generalisability of its findings to other settings should be cautious. In addition, since the COVID-19 vaccine has not yet been implemented for use among the general public, and the figures on effectiveness and safety remained unknown, an indication of willingness to receive the vaccine could be considered preliminary – which is subject to further provision of efficacy and safety profiles by pharmaceutical companies. Furthermore, intention or willingness to receive a vaccine does not necessarily translate into actual vaccine uptake, especially when there is a relatively long period of time between the measurement of willingness and observation of health promotion behaviour [34]. In addition, the present survey focused on the acceptance level among adults and future studies should be performed among adolescents and children. Finally, since the telephone survey relies on landline and there is a possibility of selection bias, although more than 91% of all Hong Kong residents were accessible to landlines.

In summary, this study has examined the factors independently associated with potential vaccine uptake. Our findings highlighted the significance of governmental recommendation on vaccine uptake, whereas perceived susceptibility to infection was not. Acceptance could be impaired by worries on newer vaccination approaches and manufacturers. These constructs and independent predictors identified provide evidence-based formulation and implementation of vaccination strategies that aim to enhance vaccine uptake.

Funding

Data sharing

After publication, the survey data will be made available on reasonable request to the corresponding author. A proposal with a detailed description of study objectives and a statistical analysis plan will be needed for assessment of requests. Additional materials might also be required during the process of assessment. De-identified participant data will be provided after approval by the investigators.

Ethics approval

This study was approved by the Survey and Behavioural Research Ethics Committee of the Chinese University of Hong Kong (Reference No. SBRE-19-796). All the participants gave informed consent before taking part.

Transparency declaration

The corresponding author, as the manuscript's guarantor, affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that there are discrepancies from the study as originally planned.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2020.12.083.

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