Factors influencing COVID-19 vaccination uptake among community members in Hong Kong: a cross-sectional online survey

Cho Lee Wong, Alice W Y Leung, Oscar Man Hon Chung, Wai Tong Chien

ABSTRACT

Objective Vaccination is recognised as the most effective approach to contain the spread of the COVID-19 pandemic in the long run. However, the global vaccination uptake is still suboptimal. Although a considerable number of studies have focused on factors influencing intention or acceptance of COVID-19 vaccination, few explore the factors that affect actual vaccination uptake. This study aimed to explore the factors influencing COVID-19 vaccination uptake among the general public in a developed country.

Design A cross-sectional online survey was conducted between June and August 2021.

Setting and participants Community members in Hong Kong were recruited through convenient and snowball sampling to complete an anonymous online survey.

Outcome measures The outcomes of this study included participants’ sociodemographic characteristics, vaccination status and perceived impact of COVID-19, and their attitudes towards COVID-19.

Results A total of 358 valid questionnaires were received. The results showed that 50.8% of the participants received two doses of the vaccine. Multivariable logistic regression analysis suggested that participants’ vaccination uptake was associated with their jobs affected by COVID-19, had an income source, perceived good/excellent physical health status, perceived COVID-19 exposure, perceived good/excellent knowledge of COVID-19, learnt about the vaccine from printed materials and perceived that their family members were at risk of contracting COVID-19.

Conclusions This is one of the first few cross-sectional studies that explored factors associated with the actual vaccination uptake of the general public during the COVID-19 pandemic. The results can provide insights for formulating strategies to increase COVID-19 vaccination rates in developed countries.

INTRODUCTION

Shortly after the COVID-19 outbreak in China around December 2019, the infection quickly spread across the globe and caused disturbances in many aspects of life. As of 31 August 2021, more than 217 million infected cases and more than 4.5 million deaths have been recorded worldwide. At the same time, Hong Kong has experienced four waves of COVID-19 infection, with confirmed cases and deaths stagnating at around 12000 and 200, respectively.

To contain the spread of the pandemic, governments around the world have adopted measures such as social distancing and border control. These measures imposed many restrictions on individuals and caused heavy health and economic losses. Alternatively, achieving herd immunity against COVID-19 through vaccinations is considered the most effective means to contain the spread of the pandemic in the long run.

As of 31 August 2021, only 27.1% of the global population has been fully vaccinated. The current vaccination rate in most countries is far below the target group herd immunity thresholds (15.3%–77.1%). Due to the ample supply of vaccines in high-income and upper-middle-income countries, the suboptimal COVID-19 vaccination rate in most countries indicates that vaccine hesitancy is prevalent. The WHO defines vaccine hesitancy as ‘the delay in acceptance or refusal of vaccination despite the availability of
vaccination services, and listed it as one of the 10 top/major threats to global health in 2019.

In Hong Kong, the government has launched a territory-wide vaccination programme on 26 February 2021, providing all Hong Kong residents with free Comirnaty (BioNTech) mRNA vaccine. The vaccination progress had been slow until a sudden surge was observed in mid-June (7-day moving average of total doses administered >40 000), which might be attributable to the government’s ‘Early Vaccination for All’ campaign, which features the facilitation and reward strategies for vaccinated people (eg, vaccination leave and relaxation of social distancing). In addition, the business sector also held some lucky draws (for example, the first prize of a HK$7 million flat, HK$1 million) to boost the COVID-19 vaccination rate. However, the current vaccination rate in Hong Kong (around 50% at the end of August) is still far from reaching the target of at least 70% of the eligible population. The suboptimal vaccination rates call for more effective strategies to overcome barriers, not just merely provide incentives.

Emerging epidemiological evidence suggests a broad array of factors that affect the intention to vaccinate against COVID-19 among the general public, including sociodemographic factors such as age, employment status, disease-specific factors such as risk perception and COVID-19 information exposure, and vaccine-specific factors such as confidence in efficacy and safety and vaccination attitudes. However, the factors influencing actual vaccine uptake have seldom been explored. A recent cross-sectional study on 1037 older Germans suggested that general health condition, the presence of chronic conditions, perceptions of infection, the severity of potential long-term effects, the efficacy of vaccines, the benefits of vaccination, the negative side effects of vaccines and the general impediments to vaccination were the determinants of actual vaccination.

After the launch of the territory-wide vaccination programme in Hong Kong, a few population-based surveys have explored the factors that influence vaccination uptake. These surveys reported a vaccine hesitancy rate of 27.6%–44.6%. The major reasons for vaccine hesitancy included physical unfit for vaccination due to medical reasons and worried about serious side effects of vaccines. In a telephone survey on Hong Kong citizens’ attitudes and opinions on vaccination, respondents who had received the vaccine had a significantly higher rating on the government’s antiepidemic efforts than those who had not been vaccinated.

Existing studies on vaccination intentions are largely conducted before the commencement of the worldwide mass vaccination programme. With the further advancement of vaccine technology and the rapid emergence of COVID-19 variants, the factors that predict the actual vaccine uptake have yet to be determined. In this context, there is an urgent need to conduct more studies to investigate the factors related to actual vaccination uptake to inform the current and future measures to promote vaccination uptake in Hong Kong and other developed countries. Therefore, this study aimed to explore the factors that affect COVID-19 vaccine uptake among general populations in Hong Kong.

METHODS
Study design
This study adopted a cross-sectional design using an online survey.

Setting and sample
Participants were recruited online from June to August 2021. Eligible participants were community members (1) aged 18 or above; (2) able to understand the instructions and items of the questionnaire in either Chinese or English and (3) given written consent (by answering ‘yes’ on the first page of the survey). Participants who self-disclosed that they had major depressive disorder, cognitive impairment, or illiteracy were excluded.

The sample size was determined to allow adequate precision to estimate the COVID-19 vaccination rate. By using the power analysis software, PASS V.16.0 (NCSS, Kaysville, USA), it was estimated that a sample size of n=340 participants would allow the study to estimate the uptake rate with a margin of error of at most ±5% at a level of significance of 0.05 based on an anticipated uptake rate of around one-third.

For the online surveys, an online survey portal was created using SurveyMonkey, a secure cloud-based online survey platform. A brief study description, consent form and questionnaires were included in the online survey portal. Participants were invited to participate in the study through the social messaging mobile application WhatsApp. A link was rolled out through various WhatsApp groups from staff working in a local university. Participants were recruited through convenient and snowball sampling. All respondents were asked to forward the link to their family and friends. Potential participants responded to the invitation by clicking a link that directed them to the online survey portal. They were asked to click the ‘yes’ button on the first page of study information and instructions to indicate their consent to participate. After consented, they would complete a set of self-developed questionnaire online, lasting about 8–10 min. The study protocol is shown in online supplemental file 1.

Survey instrument
The research team developed a set of questionnaires comprising three sections with references to previous studies of similar topics, and the current recommendations and guidelines from health authorities. The primary version was prepared in English and translated into Cantonese using standard translating procedures. The translated version was then reviewed by a panel of experts to ensure semantic and content equivalence.
A convenience sample of 20 community members of different ages was then invited to comment on the clarity of the items and whether they had difficulty in answering the questions. All of them reported they had no difficulty in understanding the questions. The questionnaire (online supplemental file 2) consisted of three sections:

1. Participants’ sociodemographic characteristics, health conditions and lifestyle characteristics, including age, gender, place of birth, living status, marital status, highest educational qualification, current employment condition, comorbidities, smoking and alcohol drinking status, perceived physical and mental health status.

2. Vaccination status and perceived impact of COVID-19: uptake of COVID-19 vaccination (yes/no), reasons for/against vaccination (an open-ended question), the impact of COVID-19 on the financial situation, contact with known/suspected cases of COVID-19, perceived COVID-19 exposure, perceived knowledge of COVID-19 and COVID-19 vaccines, sources of information about COVID-19 and COVID-19 vaccines, healthcare service used to overcome COVID-19 related stress in the past 6 months.

3. Attitudes towards COVID-19: a 10-item questionnaire developed by the research team.24 The questionnaire comprises two subscales: perceived risk of COVID-19 (seven items) and perceived self-efficacy in controlling COVID-19 (three items). Each item was rated on a 5-point Likert scale (from 1='strongly disagree' to 5='strongly agree'). The internal consistency of the scale in this study was satisfactory (Cronbach’s alpha=0.71).

**Statistical analysis**

The participant’s characteristics, including sociodemographics, health conditions and lifestyle characteristics, and experience or perceptions related to COVID-19, perceived risk of COVID-19 and perceived self-efficacy in controlling COVID-19 were categorised and presented using frequency and percentage. These characteristics were compared between the participants who had been vaccinated (at least one dose) and those who had not, using Pearson’s χ² test. Those characteristics with p<0.25 in univariate analyses were selected as candidate independent variables for a backward multivariable logistic regression analysis to delineate factors significantly and independently associated with their vaccination status. All statistical analyses were performed using IBM SPSS V.25.0 (IBM), and the level of significance was set at 0.05 (two sided).

**Patient and public involvement**

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

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**RESULTS**

**Sample characteristics**

A total of 384 community members consented online and participated in the study. Twenty-six respondents were excluded from the analyses due to having missing data on more than 30% of the questionnaire items. The remaining participants completed all the items in the questionnaire. Hence, the final sample were 358 participants (ie, completion rate=93.2%). The mean age of the participants was 38.27 (SD=14.79), and 69.0% were female. Table 1 shows a summary of the socio-demographic characteristics, health conditions and lifestyle characteristics of the participants.

**Uptake of COVID-19 vaccination and reasons**

Overall, 67.8% (243/358) of the participants had received at least one dose of the COVID-19 vaccine and, among those vaccinated, 74.9% (182/243) had received two doses. Table 2 summarises the main reasons for vaccination, and the most commonly reported reasons were ‘desire to protect self’ (70.0%) and ‘desire to protect friends/family’ (60.9%). Over half of those not vaccinated (51.4%) reported low intention (scored 0–3) to get vaccinated in the following 15 days. The most commonly cited reason for their hesitancy was their ‘concern about the side effects and safety of the vaccine’ (60.0%), followed by a ‘plan to wait and see if it is safe and may get it later’ (51.3%) (see table 2).

**Other information concerning COVID-19 impacts and vaccinations**

Table 3 summarises the information concerning COVID-19 impacts and vaccinations. The majority of them (78.2%) perceived the pandemic did not impact their financial situation. Only 7% of them had known or suspected contact(s) with COVID-19 cases, but nearly one-fifth (22.6%) perceived they had been exposed to COVID-19, and 16.4% had a consultation due to COVID-19 related stress in the last 6 months. About one-third of the participants perceived that they had good or excellent knowledge about COVID-19 (36.6%) and COVID-19 vaccines (34.3%); of which, their sources of knowledge were from the internet (70.7% and 69.8%, respectively) and television (69.8% and 62.8%, respectively). The figures of source of knowledge and comparison of information sources on COVID-19 by COVID-19 vaccination and COVID-19 vaccine by COVID-19 vaccination are shown in online supplemental file 3.

**Risk perception and self-efficacy**

The majority of the participants agreed that COVID-19 was a serious disease (73.8%); their health would be severely affected if they got infected with COVID-19 (65.7%), and they were fearful that they would become infected (58.4%) or be quarantined (58.4%). However, only a few (7.5%) perceived that they or their family members were at risk of COVID-19 infection. More than half of them were confident that they could protect themselves against...
# Table 1 Characteristics of the study sample (N=358)

| Characteristics                                         | All (N=358) | Vaccinated against COVID-19 | P value* |
|--------------------------------------------------------|-------------|-----------------------------|---------|
|                                                        | n (%)       | n (%)                       | n (%)   |         |
| **Sociodemographic characteristics**                   |             |                             |         |         |
| Age (years)                                            |             |                             |         |         |
| 18–29                                                  | 127 (35.5)  | 42 (36.5)                   | 85 (35.0) | 0.254   |
| 30–59                                                  | 202 (56.4)  | 60 (52.2)                   | 142 (58.4) |         |
| ≥60                                                    | 29 (8.1)    | 13 (11.3)                   | 16 (6.6)  |         |
| Gender                                                 |             |                             |         |         |
| Female                                                 | 247 (69.0)  | 85 (73.9)                   | 162 (66.7) | 0.166   |
| Male                                                   | 111 (31.0)  | 30 (26.1)                   | 81 (33.3)  |         |
| Born in Hong Kong                                      |             |                             |         |         |
| No                                                     | 48 (13.4)   | 13 (11.3)                   | 35 (14.4)  | 0.422   |
| Yes                                                    | 310 (86.6)  | 102 (88.7)                  | 208 (85.6) |         |
| Living status                                          |             |                             |         |         |
| Live without family members                            | 34 (9.5)    | 8 (7.0)                     | 26 (10.7)  | 0.259   |
| Live with family members                               | 324 (90.5)  | 107 (93.0)                  | 217 (89.3) |         |
| Marital status                                         |             |                             |         |         |
| Single/divorced/widowed                                | 194 (54.2)  | 60 (52.2)                   | 134 (55.1) | 0.598   |
| Cohabiting/married                                     | 164 (45.8)  | 55 (47.8)                   | 109 (44.9) |         |
| Highest educational qualification                     |             |                             |         |         |
| Secondary/higher secondary/grade 7–12 or below          | 76 (21.2)   | 32 (27.8)                   | 44 (18.1)  | 0.055   |
| Certificate/diploma/trade qualifications               | 40 (11.2)   | 15 (13.0)                   | 25 (10.3)  |         |
| Bachelor/masters/PhD                                   | 242 (67.6)  | 68 (59.1)                   | 174 (71.6) |         |
| Current employment condition                          |             |                             |         |         |
| Unemployed/home maker (no source of income)            | 102 (28.5)  | 49 (42.6)                   | 53 (21.8)  | <0.001  |
| Jobs affected by COVID-19                              | 19 (5.3)    | 6 (5.2)                     | 13 (5.3)   |         |
| Have an income source                                  | 237 (66.2)  | 60 (52.2)                   | 177 (72.8) |         |
| **Health conditions and lifestyle characteristics**    |             |                             |         |         |
| Chronic medical conditions                             |             |                             |         |         |
| No                                                     | 316 (88.3)  | 98 (85.2)                   | 218 (89.7) | 0.217   |
| Yes                                                    | 42 (11.7)   | 17 (14.8)                   | 25 (10.3)  |         |
| Smoking status                                         |             |                             |         |         |
| Never smoker                                           | 329 (91.9)  | 102 (88.7)                  | 227 (93.4) | 0.126   |
| Ever smoker                                            | 29 (8.1)    | 13 (11.3)                   | 16 (6.6)   |         |
| Current alcohol drinking (in the last 4 weeks)         |             |                             |         |         |
| No                                                     | 197 (55.0)  | 57 (49.6)                   | 140 (57.6) | 0.153   |
| Yes                                                    | 161 (45.0)  | 58 (50.4)                   | 103 (42.4) |         |
| Perceived physical health status                        |             |                             |         |         |
| Poor/fair                                              | 25 (7.0)    | 14 (12.2)                   | 11 (4.5)   | <0.001  |
| Average                                                | 165 (46.1)  | 65 (56.5)                   | 100 (41.2) |         |
| Good/excellent                                         | 168 (46.9)  | 36 (31.3)                   | 132 (54.3) |         |
| Perceived mental health status                         |             |                             |         |         |
| Poor/fair                                              | 34 (9.5)    | 18 (15.7)                   | 16 (6.6)   | <0.001  |
| Average                                                | 152 (42.5)  | 62 (53.9)                   | 90 (37.0)  |         |
| Good/excellent                                         | 172 (48.0)  | 35 (30.4)                   | 137 (56.4) |         |

Data are presented as frequency (%).

*All the p values were computed based on the Pearson χ² test.
COVID-19 (64.8%) and that the infection could finally be controlled in Hong Kong (55.7%) (see table 4).

Factors associated with uptake of COVID-19 vaccination

From the bivariate analyses (tables 1, 3 and 4), the uptake of COVID-19 vaccination was associated with current employment condition (p<0.001), perceived health status (p<0.001), perceived mental health status (p<0.001), contact with the known suspected case(s) of COVID-19 (p=0.017), perceived exposure to COVID-19 (p=0.003), perceived knowledge of COVID-19 (p<0.001), perceived knowledge of COVID-19 vaccines (p<0.001), healthcare providers as a source of knowledge about COVID-19 (p=0.004), healthcare providers (p=0.017) and brochures, posters, and other printed materials (p=0.004) as sources of knowledge about COVID-19 vaccines, perception about family members being at risk of COVID-19 infection (p=0.032), and confidence in protecting themselves against COVID-19 (p=0.031).

The results from backward multivariable logistic regression analysis (see table 5) revealed that the participants whose jobs were affected by COVID-19 (OR 4.83, 95% CI 1.18 to 19.76), had an income source (OR 2.10, 95% CI 1.18 to 3.72), perceived good/excellent physical health status (OR 5.09, 95% CI 1.17 to 22.08), perceived exposure to COVID-19 (OR 2.69, 95% CI 1.28 to 5.65), perceived to have good/excellent knowledge of COVID-19 (OR 2.65, 95% CI 1.43 to 4.93), reported learning about COVID-19 vaccines from brochures, posters and other printed materials (OR 1.95, 95% CI 1.05 to 3.63), and perceived their family was at risk of COVID-19 infection (OR 4.02, 95% CI 1.08 to 14.87) were positively associated with vaccination uptake. Alternatively, those who reported learning about COVID-19 from the internet were less likely to receive a COVID-19 vaccine (OR 0.50, 95% CI 0.26 to 0.98).

DISCUSSION

To our knowledge, this study is one of the few studies that explored the factors influencing actual vaccination uptake during the COVID-19 pandemic among community members in Hong Kong and worldwide. In our study, approximately 70% of the sample received at least one dose of the vaccine, which is higher than the officially announced vaccination uptake rate (~50%)10 and reported in two local cross-sectional studies during the same study period.22 23 Despite the high vaccination uptake, half of the unvaccinated respondents indicated that the willingness to be vaccinated in the next 15 days was low, revealing a considerable level of vaccine hesitancy in our sample. This finding echoed with other local public health studies22 23 in which the main concerns reported by unvaccinated people were the side effects and safety of available vaccines. This was also a well-recognised or commonly cited reason for vaccine hesitancy reported consistently in different countries.19-21 23-25 26 This implies that further efforts in public education should focus on conveying scientific evidence and knowledge about the efficacy and safety of various available vaccines to enhance their evidence-based decision making on vaccination.

Among various sociodemographic factors, employment condition was found to be an independent determinant of vaccination uptake. Specifically, those who were unemployed or homemaker were less likely to be vaccinated than those who were working or who had their employment affected by the COVID-19 pandemic. As an increasing number of employers adopted vaccination instead of regular testing approaches proposed by the (local) government, unvaccinated employees would require to undergo self-paid COVID-19 testing every 2 weeks.27 Such testing requirements may encourage more employers or job seekers to get vaccinated. Similarly, a recent international study found that unemployed people but not seek a job reported a lower intention to be vaccinated.13 This suggests that vaccination campaigns may effectively highlight vaccination’s financial or economic benefits to the working population (such as resuming normal business conditions and more job opportunities). Nevertheless, efforts should also be made to promote the various benefits of vaccination to the non-working population, such as a gradual return to normal life after achieving herd community.
Table 3 Information concerning COVID-19 impacts and vaccinations

| Experience or perceptions related to COVID-19 | Total (N=358) | Vaccinated against COVID-19 | P value* |
|----------------------------------------------|---------------|-----------------------------|----------|
|                                              | n (%)         | No (n=115)                 | Yes (n=243) |
| No impact impacted the financial situation   |               |                            |          |
| No impact                                    | 280 (78.2%)   | 85 (73.9%)                 | 195 (80.2%) | 0.131   |
| Yes, impacted positively                     | 17 (4.7%)     | 4 (3.5%)                   | 13 (5.3%)  |
| Yes, impacted negatively                     | 61 (17.0%)    | 26 (22.6%)                 | 35 (14.4%) |
| Contact with known/suspected case of COVID-19|               |                            |          |
| No                                           | 302 (84.4%)   | 105 (91.3%)                | 197 (81.1%) | 0.017   |
| Yes                                          | 25 (7.0%)     | 2 (1.7%)                   | 23 (9.5%)  |
| Unsure                                       | 31 (8.7%)     | 8 (7.0%)                   | 23 (9.5%)  |
| Perceived exposure to COVID-19               |               |                            |          |
| No                                           | 277 (77.4%)   | 100 (87.0%)                | 177 (72.8%) | 0.003   |
| Yes                                          | 81 (22.6%)    | 15 (13.0%)                 | 66 (27.2%) |
| Had ever used any healthcare service to overcome COVID-19-related stress in the last 6 months | | | |
| No                                           | 303 (84.6%)   | 94 (81.7%)                 | 209 (86.0%) | 0.296   |
| Yes                                          | 55 (15.4%)    | 21 (18.3%)                 | 34 (14.0%) |
| Perceived knowledge of COVID-19              |               |                            |          |
| Poor/fair                                    | 20 (5.7%)     | 10 (9.3%)                  | 10 (4.1%)  | <0.001  |
| Average                                      | 202 (57.7%)   | 76 (71.0%)                 | 126 (51.9%)|          |
| Good/excellent                               | 128 (36.6%)   | 21 (19.6%)                 | 107 (44.0%)|          |
| Perceived knowledge of COVID-19 vaccine      |               |                            |          |
| Poor/fair                                    | 33 (9.4%)     | 14 (13.1%)                 | 19 (7.8%)  | <0.001  |
| Average                                      | 197 (56.3%)   | 75 (70.1%)                 | 122 (50.2%)|          |
| Good/excellent                               | 120 (34.3%)   | 18 (16.8%)                 | 102 (42.0%)|          |
| Reported sources of knowledge about COVID-19†|               |                            |          |
| Newspapers and magazines                     |               |                            |          |
| No                                           | 185 (51.7%)   | 65 (56.5%)                 | 120 (49.4%) | 0.207   |
| Yes                                          | 173 (48.3%)   | 50 (43.5%)                 | 123 (50.6%)|          |
| Television                                   |               |                            |          |
| No                                           | 108 (30.2%)   | 36 (31.3%)                 | 72 (29.6%) | 0.747   |
| Yes                                          | 250 (69.8%)   | 79 (68.7%)                 | 171 (70.4%)|          |
| Radio                                        |               |                            |          |
| No                                           | 271 (75.7%)   | 89 (77.4%)                 | 182 (74.9%)| 0.607   |
| Yes                                          | 87 (24.3%)    | 26 (22.6%)                 | 61 (25.1)  |
| Internet                                     |               |                            |          |
| No                                           | 105 (29.3%)   | 39 (33.9%)                 | 66 (27.2%) | 0.190   |
| Yes                                          | 253 (70.7%)   | 76 (66.10)                 | 177 (72.8%)|          |
| Brochures, posters and other printed materials|             |                            |          |
| No                                           | 272 (76.0%)   | 92 (80.0%)                 | 180 (74.1%)| 0.220   |
| Yes                                          | 86 (24.0%)    | 23 (20.0)                  | 63 (25.9)  |
| Healthcare providers                         |               |                            |          |
| No                                           | 230 (64.2%)   | 86 (74.8)                  | 144 (59.3%)| 0.004   |
| Yes                                          | 128 (35.8%)   | 29 (25.2)                  | 99 (40.7)  |

Continued
This study identified several knowledge-related factors influencing vaccination uptake. In the bivariate analysis, both perceived knowledge of COVID-19 and its vaccines were associated with vaccination uptake, but only perceived knowledge of COVID-19 remained a significant factor in the multivariable model. Likewise, a recent British population-based survey showed that the perception of sufficient information/knowledge about COVID-19 and the vaccine was positively correlated with the intention to vaccinate.\(^{15}\) Regarding information sources, our study found that those who learnt about the COVID-19 vaccines through brochures, posters, and other printed materials were more likely to receive the vaccine. Interestingly, those who reported that they learnt from the internet were less likely to be vaccinated. One possible explanation for these findings is that printed materials are more likely to be produced by authoritative bodies (eg, Department of Health\(^{28}\)) based on the latest

| Table 3  Continued |
|---------------------|
| **Vaccinated against COVID-19** | **P value*** |
| | Total (N=358) | No (n=115) | Yes (n=243) |
| | n (%) | n (%) | n (%) |
| **Family members** | | | |
| No | 261 (72.9) | 82 (71.3) | 179 (73.7) |
| Yes | 97 (27.1) | 33 (28.7) | 64 (26.3) |
| **Friends, neighbours and colleagues** | | | |
| No | 231 (64.5) | 71 (61.7) | 160 (65.8) |
| Yes | 127 (35.5) | 44 (38.3) | 83 (34.2) |
| **Reported sources of knowledge about COVID-19 vaccines†** | | | |
| Newspapers and magazines | | | |
| No | 219 (61.2) | 73 (63.5) | 146 (60.1) |
| Yes | 139 (38.8) | 42 (36.5) | 97 (39.9) |
| TV | | | |
| No | 133 (37.2) | 38 (33.0) | 95 (39.1) |
| Yes | 225 (62.8) | 77 (67.0) | 148 (60.9) |
| Radio | | | |
| No | 275 (76.8) | 89 (77.4) | 186 (76.5) |
| Yes | 83 (23.2) | 26 (22.6) | 57 (23.5) |
| Internet | | | |
| No | 108 (30.2) | 39 (33.9) | 69 (28.4) |
| Yes | 250 (69.8) | 76 (66.1) | 174 (71.6) |
| Brochures, posters and other printed materials | | | |
| No | 250 (69.8) | 90 (78.3) | 160 (65.8) |
| Yes | 108 (30.2) | 25 (21.7) | 83 (34.2) |
| Healthcare providers | | | |
| No | 247 (69.0) | 91 (79.1) | 156 (64.2) |
| Yes | 111 (31.0) | 24 (20.9) | 87 (35.8) |
| Family members | | | |
| No | 279 (77.9) | 88 (76.5) | 191 (78.6) |
| Yes | 79 (22.1) | 27 (23.5) | 52 (21.4) |
| Friends, neighbours and colleagues | | | |
| No | 232 (64.8) | 70 (60.9) | 162 (66.7) |
| Yes | 126 (35.2) | 45 (39.1) | 81 (33.3) |

Data are presented as frequency (%).

*All the p values were computed based on the Pearson \(\chi^2\) test.
†Multiple responses possible.
At the same time, the internet is often fueled by the spread of inaccurate information (ie, an infodemic in which health information was mixed with fear, speculation and rumour, amplified swiftly worldwide by technologies such as the internet)\textsuperscript{29}; whereas, higher news consumption through social media was associated with lower levels of knowledge and more fake news belief.\textsuperscript{30} Previous study also revealed that fake news led healthcare professionals to get information from accurate and reliable source.\textsuperscript{31} In this regard, a recent randomised controlled trial in the UK and the USA suggested that exposure to online misinformation can reduce the public’s intention to vaccinate.\textsuperscript{18} In line with the finding that protecting friends and family is the major reason for vaccination, we found that individuals who perceived their family members were

| Table 4  | Risk perception and self-efficacy |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| **Item**        | **All (N=332)** | **Vaccinated against COVID-19** |
|                 | **n (%)**       | **No (n=103)** | **Yes (n=229)** | **P value**     |
| 1. I think COVID-19 is a serious disease |                   |
| Strongly disagree/disagree/uncertain | 87 (26.2) 34 (33.0) 53 (23.1) | 0.059 |
| Agree/strongly agree | 245 (73.8) 69 (67.0) 176 (76.9) |   |
| 2. I think I will get infected with COVID-19 |                   |
| Strongly disagree/disagree/uncertain | 307 (92.5) 99 (96.1) 208 (91.8) | 0.091 |
| Agree/strongly agree | 25 (7.5) 4 (3.9) 21 (9.2) |   |
| 3. I think my family will get infected with COVID-19 |                   |
| Strongly disagree/disagree/uncertain | 307 (92.5) 100 (97.1) 207 (91.4) | 0.032 |
| Agree/strongly agree | 25 (7.5) 3 (2.9) 22 (9.6) |   |
| 4. I am fear of getting infected with COVID-19 |                   |
| Strongly disagree/disagree/uncertain | 138 (41.6) 42 (40.8) 96 (41.9) | 0.845 |
| Agree/strongly agree | 194 (58.4) 61 (59.2) 133 (58.1) |   |
| 5. I am fearful of getting quarantined if I get infected |                   |
| Strongly disagree/disagree/uncertain | 138 (41.6) 43 (41.7) 95 (41.5) | 0.964 |
| Agree/strongly agree | 194 (58.4) 60 (58.3) 134 (58.5) |   |
| 6. My health will be severely affected if I get infected with COVID-19 |                   |
| Strongly disagree/disagree/uncertain | 114 (34.3) 39 (37.9) 75 (32.8) | 0.364 |
| Agree/strongly agree | 218 (65.7) 64 (62.1) 154 (67.2) |   |
| 7. I will not go to the hospital even if I get sick because of the risk of getting infected with COVID-19 |                   |
| Strongly disagree/disagree/uncertain | 290 (87.3) 88 (85.4) 202 (88.2) | 0.482 |
| Agree/strongly agree | 42 (12.7) 15 (14.6) 27 (11.8) |   |
| **Perceived self-efficacy in controlling COVID-19** |                   |
| 1. I believe I can protect myself against COVID-19 |                   |
| Strongly disagree/disagree/uncertain | 117 (35.2) 45 (43.7) 72 (31.4) | 0.031 |
| Agree/strongly agree | 215 (64.8) 58 (56.3) 157 (68.6) |   |
| 2. I believe COVID-19 can finally be successfully controlled |                   |
| Strongly disagree/disagree/uncertain | 147 (44.3) 51 (49.5) 96 (41.9) | 0.198 |
| Agree/strongly agree | 185 (55.7) 52 (50.5) 133 (58.1) |   |
| 3. I have confidence that Hong Kong can win the battle against COVID-19 |                   |
| Strongly disagree/disagree/uncertain | 142 (42.8) 43 (41.7) 99 (43.2) | 0.800 |
| Agree/strongly agree | 190 (57.2) 60 (58.3) 130 (56.8) |   |

Data are presented as frequency (%).
*All the p values were computed based on the Pearson $\chi^2$ test.
at risk of contracting COVID-19 were more likely to be vaccinated than those who have not reported this perception. Similarly, several reports show that consideration of others, particularly family members, regarding the threat of COVID-19 affects vaccination intention.\textsuperscript{13 15 18 21} Taken together, these results suggest that vaccination promotion messages should emphasise the generous benefits of vaccination to significant others and society at large, for example, the effectiveness of vaccination in reducing the infection risk at individual and collective levels.\textsuperscript{32}

In this study, people’s perceived COVID-19 exposure independently predicted their vaccination uptake. To our knowledge, this factor has not been reported as a predictor of vaccination intention or acceptance in previous studies. It can be speculated that those who perceive that they have not been exposed to the COVID-19 may not feel the urgency of vaccination, leading to vaccine hesitancy. Notably, the final regression model was perceived to have good/excellent physical health status as the strongest factor for vaccination uptake. Likewise, this factor has

| Table 5 Factors associated with the uptake of COVID-19 vaccination |
|---------------------------------------------------------------|
| **Factors retained in backward logistic regression analysis** | **OR (95% CI)** | **P value** |
| **Sociodemographic characteristics** | | | |
| Current employment condition | | | |
| Unemployed/home maker (no source of income) (ref) | 1 | | |
| Jobs affected by COVID-19 | 4.83 (1.18 to 19.76) | 0.029 |
| Have an income source | 2.10 (1.18 to 3.72) | 0.011 |
| **Health conditions and lifestyle characteristics** | | | |
| Perceived physical health status | | | |
| Poor/fair (ref) | 1 | | |
| Average | 3.17 (0.80 to 12.63) | 0.101 |
| Good/excellent | 5.09 (1.17 to 22.08) | 0.030 |
| Perceived mental health status | | | |
| Poor/fair (ref) | 1 | | |
| Average | 1.47 (0.49 to 4.38) | 0.490 |
| Good/excellent | 3.23 (0.99 to 10.53) | 0.052 |
| **Experience or perceptions related to COVID-19** | | | |
| Perceived exposure to COVID-19 | | | |
| No (ref) | 1 | | |
| Yes | 2.69 (1.28 to 5.65) | 0.009 |
| Perceived knowledge of COVID-19 | | | |
| Poor/fair | 1.12 (0.28 to 4.53) | 0.875 |
| Average (ref) | 1 | | |
| Good/excellent | 2.65 (1.43 to 4.93) | 0.002 |
| **Sources of knowledge** | | | |
| Reported internet as a source of knowledge about COVID-19 | | | |
| No | 1 | | |
| Yes | 0.50 (0.26 to 0.98) | 0.045 |
| Reported brochures, posters and other printed materials as sources of knowledge about COVID-19 vaccines | | | |
| No | 1 | | |
| Yes | 1.95 (1.05 to 3.63) | 0.035 |
| **Perceived risk of COVID-19** | | | |
| I think my family will get infected with COVID-19 | | | |
| Strongly disagree/disagree/uncertain | 1 | | |
| Agree/strongly agree | 4.02 (1.08 to 14.87) | 0.037 |

*Significant factors retained from backward multivariable logistic regression analysis using the variables as listed in tables 1, 3 and 4 with p<0.25 in the univariate analysis as candidate independent variables. ref, reference category of the categorical independent variable.
been found to predict the intention of vaccination against COVID-19 among the general population in China, and actual vaccination uptake in a sample of the elderly population in Germany. It could be possible that people who perceive they were in poor health might be more worried about the vaccine’s side effects, which would become a major obstacle to vaccination.

Limitations
This study has several limitations. First, this study adopted a cross-sectional design so that the causality between vaccination uptake and other variables could not be determined. Second, a non-random sample was used; and this might lead to selection bias and limit the generalisability of the findings. Third, the sample was found to be over-represented by female, highly educated and younger adults, so caution is needed to be taken when generalising the findings to the general population in Hong Kong. Finally, self-report questionnaires might also be subject to social desirability bias and inaccurate understanding and responses to the questionnaire, thereby reducing the reliability and validity of the findings.

CONCLUSION
This study is one of the few survey studies to explore the reasons and factors associated with the ‘actual’ vaccination uptake among the general population during the COVID-19. The results provide evidence and insights for formulating effective strategies to promote COVID-19 vaccination in Hong Kong and other developed countries.

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Contributors
CLW and WTC contributed to the study’s conception and design. CLW was involved in gaining ethical approval. CLW, AWYL, and OMHC analysed the data and wrote the first draft of the manuscript. All authors reviewed and edited the manuscript and approved the final version of the manuscript. CLW acted as guarantor of this study.

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Competing interests
The authors declare that there is no conflict of interest.

Patient consent for publication
Not required.

Ethics approval
Ethical approval was obtained from the Survey and Behavioural Research Committee of The Chinese University of Hong Kong (SBCR-20-784). The Helsinki Declaration handled all study procedures involving human subjects. The participants were assured that their participation was voluntary, their rights to withdraw at any time were upheld, and their information was confidential.

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Data availability statement
Data are available on reasonable request. The anonymous data which form the basis for this study are available from the authors on reasonable request.

Supplemental material
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ORCID iDs
Cho Lee Wong http://orcid.org/0000-0001-6640-1323
Alice WY Leung http://orcid.org/0000-0001-5217-0464
Wai Tong Chien http://orcid.org/0000-0001-5321-5791
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Factors influencing COVID-19 vaccination uptake among community members in Hong Kong: a cross-sectional online survey

Background: The continued spread COVID-19 in Hong Kong poses a significant impact on community members. Vaccination is recognised to be the most effective approach to contain the spread of the COVID-19 pandemic in a long run. However, the vaccination uptake in Hong Kong is still suboptimal. Little is known about the factors that influence COVID-19 vaccination uptake among the general public in Hong Kong.

Purpose: To examine factors that affect actual COVID-19 vaccination uptake among community members in Hong Kong.

Design: A cross-sectional design.

Methods: A total of 340 community members will be recruited online. A set of self-developed questionnaire will be used to assess sociodemographic characteristics, vaccination status, perceived impact of COVID-19, and their attitudes towards COVID-19.

Data analysis: Quantitative data analysis will be conducted.

Potential significance: The findings are imperative to inform strategies to increase COVID-19 vaccination rates in Hong Kong.
Introduction

Coronavirus disease 2019 (COVID-19) is an emerging respiratory disease caused by a novel coronavirus (Wang et al., 2020). The disease was first discovered in Wuhan, Hubei Province in December 2019 (Bai et al., 2020). The ongoing COVID-19 pandemic has spread quickly, with confirmed cases having been reported in the majority of countries worldwide. The World Health Organisation (WHO) declared the disease a public health emergency of international concern on January 30 and called on all countries to work together to prevent the worsening of the pandemic (WHO, 2020). Some unprecedented restrictive measures have been implemented in several countries to contain its spread, including strict “lock down” regulations, closing of premises and public places, compulsory quarantine measures, and isolation care for infected persons and suspected cases. As of April 6, 2021, statistics on the WHO Coronavirus Disease (COVID-19) Dashboard show that the virus has spread to 221 countries, with approximately 131.02 million confirmed cases and over 2.85 million deaths (WHO, 2021a). Compared with other countries in the world, Hong Kong is moderately affected by the COVID-19 pandemic, but is being struck with the fourth wave of COVID-19 in recent days. Since the outbreak, a total of 11,532 COVID-19 cases have been recorded, of which 205 people have died of this disease (Centre for Health Protection, 2021).

Vaccination is one of the most effective ways to prevent further morbidity and mortality and to promote herd immunity. As of February 18, 2021, at least seven different COVID-19 vaccines have been launched on three platforms in different countries, including inactivated or weakened virus vaccines, protein-based vaccines, viral vector vaccines, and RNA and DNA vaccines (WHO, 2021b). In Hong Kong, a territory-wide COVID-19 Vaccination Programme free of charge and on a voluntary basis for all eligible residents has been implemented by the Hong Kong government to protect members of public against COVID-19. Two intramuscular administered COVID-19 vaccines have been authorized for use: Inactivated (CoronaVac) and COMIRNATYTM COVID-19 mRNA Vaccine (BNT162b2) (COMIRNATY). Individuals are required to receive two doses of the same vaccine to build up adequate protection. As of 5 April 2021, about 487,000 Hong Kong people have been vaccinated for 1st dose, and 90,200 have fully vaccinated (The Government of Hong Kong Special Administrative Region, 2021). Nevertheless, herd immunity against COVID-19 requires at least 70% of population to be vaccinated. The slow vaccination progress calls for more effective strategies to overcome barriers.

Emerging epidemiological evidence suggests a broad array of factors that may affect vaccination intention among the general public, including sociodemographic factors such as
age (Sherman et al., 2021; Soares et al., 2021) and employment status (Soares et al., 2021); disease-specific factors such as risk perception (Malesza & Wittmann, 2021; Sherman et al., 2021;) and COVID-19 information exposure (Loomba, de Figueiredo, Piatek, de Graaf, & Larson, 2021; Malesza & Wittmann, 2021; Sherman et al., 2021; Soares et al., 2021;) and vaccine-specific factors such as confidence in efficacy and safety (Malesza & Wittmann, 2021; Sherman et al., 2021; Soares et al., 2021; Wong et al., 2021) and vaccination attitudes (Sherman et al., 2021). However, the major factors influencing actual vaccine uptake have seldom been explored. A recent cross-sectional study on 1,037 older Germans suggested that general health condition, the presence of chronic conditions, perceptions of infection, the severity of potential long-term effects, the efficacy of vaccines, the benefits of vaccination, the negative side-effects of vaccines and the general impediments to vaccination were the factors influencing actual vaccination (Malesza & Wittmann, 2021).

Existing studies on vaccination intentions are largely conducted prior to the commencement of the worldwide mass vaccination programmes. As far as we know, there is no known information about the factors influencing actual vaccination uptake. Therefore, the novelty of this study is to examine the factors that affect actual vaccination uptake among community members of Hong Kong.

Methods
Study design

This study uses a cross-sectional design.

Setting and sample

Participants will be recruited online. To be eligible to participate in this study, potential community members are (1) 18 years of age or older; (2) able to communicate in Chinese or English. Participants who suffer from cognitive impairment or self-disclose of having major depressive disorder will be excluded. The sample size is determined to allow adequate precision to estimate the COVID-19 vaccination rate. By using the power analysis software, PASS 16.0 (NCSS, Kaysville, US), it is estimated that a sample size of n=340 participants would allow the study to estimate the uptake rate with a margin of error of at most ±5% at a level of significance of 0.05 on the basis of an anticipated uptake rate of around one-third.

For the online survey, an online survey portal will be created using SurveyMonkey, a secure cloud-based online survey platform. The brief study description, consent forms and questionnaires will be included in the online survey portal. Participants will be invited to COVID-19_Proposal_v1_13.04.2021

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participate the study via convenience and snowball sampling methods. Participants will be responded to the invitation by clicking a link that direct them to the online survey portal. They will be asked to click the “yes” button to indicate their consent to the study and complete the socio-demographics and background information as well as a set of self-developed questionnaire online.

Survey Instrument

A set of questionnaires comprised of three sections is developed by the research team with references to previous studies of similar topics (Malesza & Wittmann, 2021; Soares et al., 2021; Wong et al., 2020). The questionnaire has been reviewed by a panel of experts and will be validated with 20 participants representing the target population before the main study for their understanding of the questionnaire content before the main study.

The questionnaire consists of three sections that aim to collect the following information from the participants:

1. Participants’ socio-demographic characteristics, health conditions and lifestyle characteristics, including age, gender, place of birth, living status, marital status, highest educational qualification, current employment condition, co-morbidities, smoking and alcohol drinking status, perceived physical and mental health status.

2. Vaccination status and perceived impact of COVID-19: uptake of COVID-19 vaccination (yes/no), reasons for/against vaccination (an open-ended question), impact of COVID-19 on financial situation, contact with known/suspected cases of COVID-19, perceived COVID-19 exposure, perceived knowledge of COVID-19 and COVID-19 vaccines, sources of information about COVID-19 and COVID-19 vaccines, healthcare service used to overcome COVID-19 related stress in the past six months.

3. Attitudes towards COVID-19: a 10-item questionnaire developed by the research team (Wong et al., 2020). The questionnaire comprises two subscales: perceived risk of COVID-19 (7 items) and perceived self-efficacy in controlling COVID-19 (3 items). Each item is rated on a 5-point Likert scale (from 1=’strongly disagree’ to 5=’strongly agree’.

Statistical analysis

IBM SPSS Statistics for Windows version 25.0 (IBM Corp., Armonk, NY, USA) will be used for statistical analysis. For the online questionnaire responses, they will be downloaded, coded and input into the SPSS. Descriptive statistics, such as mean and standard deviations
(SD) for continuous variables and proportions for categorical variables, will be used to summarize outcome variables as well as participants’ demographics characteristics. These characteristics will be compared between the participants who had vaccinated (at least one dose) and those who had not, using Pearson’s chi-square test. Those factors showing significance ($p < 0.25$) in bivariate analyses will be selected as candidate variables for backward multivariable logistic regression analysis to delineate factors significantly associated with their vaccination status. The statistical significance level is set at $p < 0.05$ (two-sided).

**Ethical consideration**

Ethical approval will be obtained from the Chinese University of Hong Kong’s Survey and Behavioural Research Committee. All study procedures involving human participants will be handled in accordance with the Helsinki Declaration. The participants will be assured that their participation is voluntary, their rights to withdraw at any time will be upheld and their information will be confidential. All information will be kept safely in a locked file that could only be accessed by the researcher. All data will be destroyed six months after the project has completed.

**Significance of the study**

This study is one of the few survey studies aims at exploring the reasons and factors associated with the ‘actual’ vaccination uptake among general population during the COVID-19. The results will provide evidence and insights for formulating effective strategies to promote COVID-19 vaccination in Hong Kong and other developed countries.
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Factors influencing COVID-19 vaccination uptake among community members in Hong Kong: a cross-sectional online survey

Questionnaires - English version

Part 1. Socio-demographics and background information:

1. Age: _________ (in years)

2. Gender:
   - Male
   - Female

3. Place of birth:
   - Hong Kong
   - Mainland China
   - Others, please specify: __________

4. Living status:
   - Live without family members
   - Live with family members

5. Marital status:
   - Single, divorced, widowed
   - Cohabiting, Married

6. Highest educational/vocational qualification:
   - Primary/Grade 1 to 6
   - Secondary/Higher Secondary/Grade 7 to 12
   - Certificate/Diploma/Trade qualifications
   - Bachelor/Masters/PhD

7. Current employment condition:
   - Unemployed/Housewife/Home maker/Home duties (No source of income)
   - Jobs affected by COVID-19 (lost job/working hours reduced/afraid of job loss)
   - Have an income source (employed/Government benefits)

8. COVID-19 impacted the financial situation:
   - No impact
   - Yes, impacted positively
   - Yes, impacted negatively

9. Chronic medical condition:
   - No
   - Yes, please specify____________

10. Smoking:
    - Never smoker
    - Ever smoker (Daily/Non-daily/Ex)

COVID-19 _English version
11. Increased smoking over the last 6 months:
- No
- Yes

12. Current alcohol drinking (last 4 weeks):
- No
- Yes

13. Increased alcohol drinking over the last 6 months:
- No
- Yes

14. Contact with known/suspected cases of COVID-19:
- No
- Unsure
- Yes, indirect contact
- Yes, provided direct care

15. Experience related to COVID-19 pandemic (multiple response possible):
- No known exposure to COVID-19
- Tested positive for COVID-19
- Tested negative for COVID-19
- Had recent overseas travel history and was in quarantine

16. Perceived physical health status:
- Poor
- Fair
- Average
- Good
- Excellent

17. Perceived mental health status:
- Poor
- Fair
- Average
- Good
- Excellent

18. Healthcare service use related to COVID-19 in the last six months:
- No
- Consulted a GP
- Consulted a Psychologist
- Consulted a Psychiatrist
- Used specialised mental healthcare settings
- Use mental health resources
- Use mental health resources available through media
- Use mental health support services
- Use combination of services

19. Where did you learn about COVID-19? (multiple response possible)
- Newspapers and magazines
- TV
- Radio
- Internet
- Brochures, posters and other printed materials
- Healthcare providers
- Family members
- Friends, neighbours, and colleagues
20. How would you rate your knowledge level on COVID-19?
- Poor
- Fair
- Average
- Good
- Excellent

21. Where did you learn about COVID-19 vaccines? (multiple response possible)
- Newspapers and magazines
- TV
- Radio
- Internet
- Brochures, posters and other printed materials
- Healthcare providers
- Family members
- Friends, neighbours, and colleagues
- Others, please specify ________________________________________

22. How would you rate your knowledge level on COVID-19 vaccine?
- Poor
- Fair
- Average
- Good
- Excellent

23. Have you vaccinated against COVID-19:
- Yes, taken 1st dose (CoronaVac)
- Yes, taken 1st dose (Comirnaty)
- Yes, completed two doses (CoronaVac)
- Yes, completed two doses (Comirnaty)
- No (please go to question 27 and question 28)

24. Where have you been vaccinated against COVID-19 in the past 15 days:
- Community Vaccination Centres
- Designated general outpatient clinics (GOPCs) of the Hospital Authority
- Designated private clinics
- Residential care homes and nursing homes
- Designated clinics of the Department of Health (DH)

25. Reasons for vaccinate against COVID-19:
- Desire to help flatten the curve of disease
- Desire to protect self
- Desire to protect friends/ family
- Desire to travel abroad
- Compulsory in the workplace
- Others, please specify ________________________________

26. Reasons for choosing the COVID-19 vaccine from the available types: _________________

27. Reasons for not vaccinate against COVID-19:  ____________________________
- Concern about the side effects and safety of the vaccine
- The vaccine is being developed too quickly
- Plan to wait and see if it is safe and may get it later
- The doctor did not recommended me for COVID-19 vaccination
- The vaccine will not work
- Don’t like needles
28. How likely you will take the COVID-19 vaccine in the next 15 days?

|       | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|-------|---|---|---|---|---|---|---|---|---|---|----|
| (definitely no) |             |             |             |             |             |             |             |             |             |             | (definitely yes) |

**Part 2. Attitudes towards COVID-19**

Please select the answer depending on how much you agree with the statements.

| Statement                                                                 | Strongly disagree | Disagree | Uncertain | Agree | Strongly agree |
|---------------------------------------------------------------------------|-------------------|----------|-----------|-------|----------------|
| 3.1 I think COVID-19 is a serious disease.                                |                   |          |           |       |                |
| 3.2 I think I will get infected with COVID-19.                            |                   |          |           |       |                |
| 3.3 I think my family will get infected with COVID-19.                    |                   |          |           |       |                |
| 3.4 I am fear of getting infected with COVID-19.                          |                   |          |           |       |                |
| 3.5 I am fearful of getting quarantined if I get infected.                |                   |          |           |       |                |
| 3.6 My health will be severely affected if I get infected with COVID-19. |                   |          |           |       |                |
| 3.7 I will not go to the hospital even if I get sick because of the risk of getting infected with COVID-19. |                   |          |           |       |                |
| 3.8 I believe I can protect myself against COVID-19.                      |                   |          |           |       |                |
| 3.9 I believe COVID-19 can finally be successfully controlled.            |                   |          |           |       |                |
| 3.10 I have confident that Hong Kong can win the battle against COVID-19. |                   |          |           |       |                |

-THE END-

- THANK YOU FOR YOUR PARTICIPATION-
Figure 1 Source of knowledge about COVID-19 and COVID-19 vaccine

Figure 2 Comparison of information sources on COVID-19 by COVID-19 vaccination
Figure 3 Comparison of information sources on COVID-19 vaccine by COVID-19 vaccination