



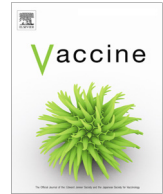
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Priming with social benefit information of vaccination to increase acceptance of COVID-19 vaccines



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ABSTRACT

Vaccine hesitancy can be heightened due to increasing negative reports about vaccines. Emphasizing the social benefits of vaccination may shift individual attention from individual to social benefit of vaccination and hence promote prosocial vaccination. In six rounds of a population-based survey conducted over one major community epidemic of coronavirus disease 2019 (COVID-19) in Hong Kong from June to November 2020, we manipulated the question asking about acceptance of a COVID-19 vaccine with or without emphasizing the social benefit of vaccination against COVID-19 (prosocial priming) and monitored the changes of vaccine confidence by news media sentiment on vaccines. Population-weighted percentages of accepting COVID-19 vaccines by priming condition and vaccine confidence were compared across survey rounds. Logit regression models assessed the main effect of prosocial priming and the modification effects of vaccine confidence and perceived personal risk from COVID-19 on acceptance of COVID-19 vaccines. We found that prosocial priming significantly increased acceptance of COVID-19 vaccines across all survey rounds except for Round 3 when incidence of COVID-19 reached a peak. Vaccine confidence significantly declined in Round 6 when news media sentiment on vaccines became predominantly negative. The effect of prosocial priming on promoting vaccine acceptance was significantly greater in participants with low vaccine confidence and those perceiving the severity of COVID-19 to be mild/very mild. Our study suggests that packaging vaccination against COVID-19 as a prosocial behaviour can help overcome low vaccine confidence and promote prosocial vaccination particularly when disease incidence temporarily declines and the public perceive low severity of COVID-19.

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1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic has caused enormous disruption to societies and their economies, as well as the loss of millions human lives globally. International efforts have been made to ensure fair and equitable access to safe and effective COVID-19 vaccines particularly for low- and middle-income countries [47]. However, mere vaccine accessibility will be insufficient to ensure high coverage rate of the vaccination in the population to achieve herd immunity. A global survey conducted in 19 countries in June 2020 reported an overall acceptance rate of more than

70% for a potentially safe and effective COVID-19 vaccines [27]. However, an initially high intention to receive a COVID-19 vaccine may decline when community incidence of the disease declines [7,29,39] or when the public lose confidence in vaccines [8].

Vaccine hesitancy could increase as the pandemic appears under control and media attention shifts from disease risk to vaccine risk and thereby is an important obstacle to the achievement of high vaccination uptake and herd immunity [25]. Vaccine hesitancy describes a continuum of vaccination decision ranging from completely rejecting the vaccine to contemplating and delaying acceptance of the vaccine [32]. It is closely related to vaccine confidence such as concern about vaccine safety and perception of low effectiveness of the vaccine and can be fuelled by negative or incorrect information about vaccines received from different media [9,11,31,43]. However, merely educating people about the safety

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and efficacy of the vaccines may be insufficient to address vaccine hesitancy [21,33,34] as vaccine hesitancy may be rooted in certain moral values and distrust in authorities and science [1,20,35].

One underlying reason for vaccine hesitancy is that vaccination has typically been framed as an individual choice, where individuals' risk and benefit become the central consideration. Thus, an individualistic rational model of vaccination decision-making such as Health Belief Model [2,3] and Protection Motivation Model [40–41] assumes that when individuals perceive that benefit from vaccination outweighs the risk from it, they would opt for vaccination [7] but would refuse vaccination to avoid any vaccine-related risk when they perceive reduced risk of infection due to increase in vaccination rates in the community [6,16,30]. However, in addition to individual protection, vaccination also provides social benefits because each individual vaccination can contribute to community benefits through the achievement and maintenance of herd immunity. This means that vaccination is not only an individual decision but also a prosocial behaviour. Emphasizing the social benefits of vaccination may shift individual attention from individual interest to social welfare of vaccination and hence reduce concern over vaccine risk and promote prosocial vaccination [5,23]. Such strategy can be termed 'prosocial priming' because it prime individual's social responsibility, empathy with others and altruism when making vaccination decision [5,23,24,37]. One online experiment suggested that providing information of herd immunity can increase willingness to take a hypothetical vaccine in scenario of a less but not a highly contagious disease [5]. This indicates that perceived disease risk can modify the effect of prosocial priming on vaccine acceptance with high perceived personal risk from the disease saliently making individuals more attentive to individual risk during vaccination decision and thereby reducing the impact of prosocial priming [10,30]. However, there remained limited evidence on the effects of prosocial priming on acceptance for a foreseeable pandemic vaccine.

This study was aimed to examine the effect of prosocial priming on acceptance of COVID-19 vaccines across pandemic phases of different severity using samples randomly recruited from the population. We hypothesized that:

- H1. Prosocial priming (emphasizing the social benefit of taking COVID-19 vaccination) will increase public acceptance of COVID-19 vaccines;
- H2. Vaccine confidence will decline but distrust in the safety of COVID-19 vaccines will increase when news media sentiment on vaccine becomes more negative;
- H3. The effect of prosocial priming on promoting acceptance of COVID-19 vaccines will be greater for participants who have lower vaccine confidence and those who perceive lower personal risk from COVID-19.

2. Methods

2.1. Data collection

This study obtained data from a project of population-based weekly cross-sectional surveys on "public psychobehavioural response to COVID-19" conducted in Hong Kong in response to the emergence of COVID-19. The sample size of each weekly round alternated between 500 and 1000 to match the available budget. Data from six cross-sectional survey rounds that assessed acceptability for COVID-19 vaccines and general vaccine attitudes were used for the current study. These six survey rounds were conducted in June–November 2020 with the first round conducted during a period when COVID-19 incidence was low, the second and the third rounds when community incidence was high, and the last three rounds when community incidence was lower again

(Fig. 1). Residential landline penetration rate was estimated to be 81.9% while mobile penetration rate was more than 90% in 2020 in Hong Kong [19]. Hence, participants were recruited using random digital dialling with telephone numbers randomly generated by computer based on a ratio of 1:1 for landline to mobile phone numbers. An adult whose birthday was soonest following the interview date for each residential call or the owners of the mobile phone numbers for the mobile phone calls were invited to participate in the survey. This sampling method was aimed to avoid missing households that did not register for a landline [14]. Participant eligibility required Chinese Cantonese fluency, the mother tongue of 90% of the Hong Kong population. All calls were made during both working and non-working hours to avoid oversampling non-working participants. Telephone numbers were newly generated for each round to enable recruitment of new participants. At least four additional attempts were made before classifying the non-response calls as invalid. The study received ethical approval from the Institutional Review Board of the University of Hong Kong.

2.2. Prosocial priming and intention to accept COVID-19 vaccines

In each of the six rounds, two versions of the questionnaire were used. The mere difference between the two versions of the questionnaire was the introductory scenario given before asking participants about their intention to receive a COVID-19 vaccine. In Version1, the question used for assessing intention to accept a COVID-19 vaccine were: "If a coronavirus vaccine is available for Hong Kong people and free, how likely will you take the novel coronavirus vaccine?" In Version2, prior information about the potential benefit of taking COVID-19 vaccination for individuals and the community was added before asking participants about their intention to accept a COVID-19 vaccine. Specifically, the prior information included was: "Taking a COVID-19 vaccine may benefit not only individuals but also the whole society. If most people in Hong Kong are vaccinated, it can minimize the disruption of the pandemic on social economics and people's daily life and protect vulnerable others such as young babies and elderly." Since this introductory information put more emphasis on the social benefit of vaccination, we termed it 'prosocial priming'. One of the two questionnaire versions was randomly assigned to participants using computer-generated numbers. Interviewers were trained in advance to minimize variability in reading the introductory scenario information and biases when asking questions about intention to accept a COVID-19 vaccine. Responses were recorded using a seven-point format ("never", "very unlikely", "unlikely", "evens", "likely", "very likely" and "certain"). Participants' COVID-19 vaccination intention was categorized as "accepting" for responses of "likely/very likely/certain" and "hesitancy/rejecting" for responses of "never/very unlikely/unlikely/evens" to the question measuring COVID-19 vaccination intention.

2.3. Other study measures

General vaccine confidence: The standard four-item global vaccine confidence scale was used to assess their confidence in vaccination importance, effectiveness, safety and value/religious compatibility [26]. Response format for each item was five-point categorical agreement (1–5). A mean score of the four items was generated to represent general vaccine confidence.

Perceived personal risk from COVID-19: We used one item to assess perceived personal susceptibility to COVID-19, scored with a seven-point response format ("never", "very unlikely", "unlikely", "evens", "likely", "very likely" and "certain"). Another item was used to assess how serious they thought COVID-19 would be for

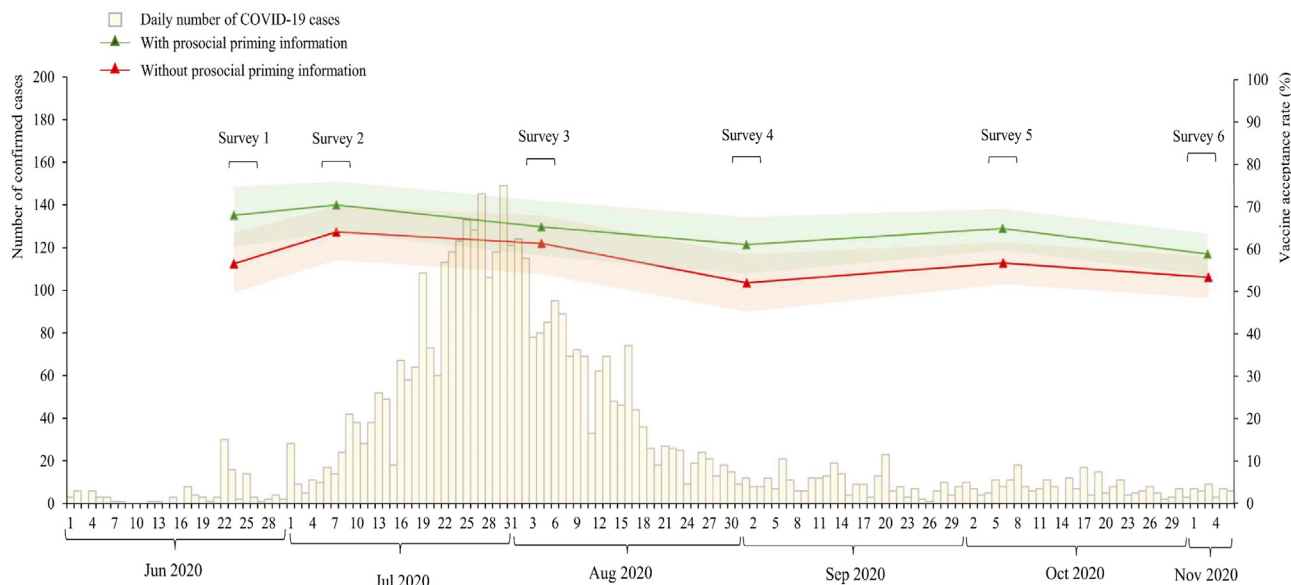


Fig. 1. Acceptance rates for a COVID-19 vaccine across the six rounds of survey and timing of each survey round. The shaded area of each line indicates the 95% confidence interval.

themselves with response options of “very mild”, “mild” and “moderate” to “serious” and “very serious”.

In addition, in every survey round, participants were asked about their perceptions of COVID-19 vaccine effectiveness for reducing personal risk of COVID-19 infection (5-point categorical scale), and perceived safety of COVID-19 vaccines (5-point categorical scale), as well as demographics including sex, age and educational attainment.

2.4. Sentiment analysis of news media on vaccines

News articles relating vaccines including COVID-19 and other vaccines published between June and November 2020 were retrieved from the WiseNews Database, a leading media monitoring platform of printed and online media. We chose the top 10 news agencies in Hong Kong as the database but excluded one English newspaper because it has restriction in public accessibility. A total of 799 news articles with “vaccine” in their headlines were finally included for sentiment analysis. The sentiment analysis was conducted using the Baidu Application Program Interface (API) because of its high capacity for analysing Chinese characters. To check the accuracy of Baidu API for sentiment analysis of vaccine-related news, two researchers independently coded the sentiment polarity (positive, negative or neutral) of a random subset of 10% of the retrieved articles. By comparing the manual classification of sentiment polarity of vaccine-related news, we found that the Baidu API had an accuracy rate of 92.5%. Then, all headlines of the retrieved articles were analysed in Python for their sentiments using Baidu API.

2.5. Statistical analysis

Normality test was conducted for intention to take a COVID-19 vaccine, general vaccine confidence, perceived personal susceptibility and perceived severity using Shapiro-Francia test. All variables were not normally distributed. The distributions of these main study measures were detailed in [Appendix Table 1 \(Supplementary Materials\)](#). Therefore, these variables were treated as categorical variables for subsequent analysis. General vaccine confidence was categorized as low, moderate and high vaccine

confidence based on a mean score of general vaccine confidence of 1.0–2.0, 2.1–3.0 and 3.1–5.0, respectively. Perceived personal susceptibility to COVID-19 was categorized as low, moderate and high for perceiving a likelihood of being “never/very unlikely/unlikely”, “evens” and “likely/very likely/certain” infected by COVID-19. In addition, perceived severity from COVID-19 was categorized as “mild/very mild”, “moderate” and “serious/very serious”. Some participants answered “unsure” to the main study measures. These were the participants who felt uncertain (e.g., “hard to say”, “don’t know” or “unsure”) when they were asked about their intention to accept a COVID-19 vaccine, their confidence in vaccine, and personal risk to and from COVID-19. The “unsure” proportions were 3.9% for intention to accept a COVID-19 vaccine, 4–7% for the items assessing general vaccine confidence, 5.7% for perceived susceptibility to COVID-19 and 3.8% for perceived severity from COVID-19. We first treated these “unsure” response as valid data for the main analysis by categorizing the “unsure” response as “hesitancy or rejecting” a COVID-19 vaccine for the question assessing COVID-19 vaccination intention, as “moderate vaccine confidence” for the general vaccine confidence measures, and as “moderate” perceived susceptibility and “moderate” perceived severity for their respective study measures. Then, as a sensitive analysis, participants who gave the “unsure” response were excluded to repeat all analyses.

The proportions of accepting a COVID-19 vaccine, levels of general vaccine confidence and attitudes towards COVID-19 vaccines were weighted by sex and age to the general population and were directly compared across survey rounds and/or priming condition. Vaccine acceptance rates across demographic strata, and levels of vaccine confidence and perceived personal risk from COVID-19 were calculated using adjusted predicted probabilities (marginal effects) after running the logit models. To examine the interaction effects of prosocial priming with vaccine confidence and perceived risk from COVID-19, the respective interaction terms were included into the logit models. Subsequently, predicted margins were used to obtain the predicted vaccine acceptance rates adjusting for covariates in the logit model. P-values of <0.05 were treated as statistically significant. All data analyses were conducted using Stata 15.0 (StataCorp LLC, 2018). Major syntaxes that were used for the analyses are provided in [Appendix 3, Supplementary Materials](#).

3. Results

3.1. Participants

A total of 4,055 participants completed the six rounds of the survey, with a sample size of ~500 in each of the first four rounds and ~1,000 in each of the last two rounds. Survey cooperation rates, defined as number of subjects completing the interviews dividing by number of contacted subjects, ranged between 60% and 70% across survey round. Distributions of participants' sex, age and educational attainment were comparable with the most recent census data (Table 1). Participants did not significantly differ by sex distributions but significantly differed by distributions of age and educational attainment across surveys (Table 1). However, there were no significant differences in distributions of sex, age and educational attainment of participants completing the questionnaires with and without prosocial priming information overall and across survey rounds (Appendix Table 2, Supplementary materials).

3.2. Vaccine acceptance by priming condition

Rates of accepting a COVID-19 vaccine were stable in Round 1–3 but significantly declined thereafter (Fig. 1). Prosocial priming had a significant overall effect, increasing public acceptance of a COVID-19 vaccine ($p < 0.001$), with COVID-19 vaccine acceptance rate being 64.5% (95% confidence interval, CI: 62.1–66.8%) in the prosocial priming condition and 56.7% (95% CI: 54.3–59.1%) without prosocial priming. In stratified analysis by survey round, the effect of prosocial priming was only statistically significant in Round 1 (68.4% (95% CI 61.3–75.4%) for the priming condition and 56.5% (95% CI 49.8–63.2%) for no priming condition, $p = 0.019$), Round 4 (61.6% (95% CI 54.8–68.0%) for the priming condition and 52.0% (95% CI 45.2–58.7%) for no priming condition, $p = 0.048$) and Round 5 (65.3% (95% CI 60.3–69.9%) for the priming condition and 56.7% (95% CI 51.7–61.6%) for no priming condition, $p = 0.016$) (Fig. 1). After adjusting for vaccine confidence, prosocial priming had significant effects on COVID-19 vaccine acceptance in all survey rounds except for Round 3 (details can be found in Table 2).

3.3. General vaccine confidence and attitudes towards COVID-19 vaccines with vaccine news media sentiments

Overall, 3.8% (95% CI: 3.1–4.5%) and 17.0% (95% CI: 15.7–18.4%) of the participants were classified as having low and moderate vaccine confidence, respectively. About 14.2% (95% CI: 13.1–15.5%)

disagreed/strongly disagreed that COVID-19 vaccines would be safe but 70.1% (68.5–71.6%) agreed/strongly agreed that the vaccines would be effective. Rate of low vaccine confidence was lowest (2.1% (95% CI: 1.2–3.7%)) in Round 3 immediately after community incidence of COVID-19 peaked but significantly increased to 6.3% (95% CI: 4.7–8.4%) in Round 6 when news media sentiment on vaccines became predominantly negative (Fig. 2). Distrust in the safety of COVID-19 vaccines was doubled from 9.4% (95% CI: 7.0–12.7%) in Round 1 to 18.6% (95% CI: 16.0–21.4%) in Round 6 (Fig. 2). Perceived effectiveness of COVID-19 vaccine did not change significantly across the six rounds.

3.4. The modification effect of general vaccine confidence

There was no significant interaction effect between prosocial priming and sex, age or educational attainment of the participants on vaccine acceptance. After adjusting for prosocial priming condition, COVID-19 vaccine acceptance rate was lower in females (58.5%, 95% CI: 56.4–60.5%) than males (63.7%, 95% CI: 61.5–65.9%), in participants aged 18–34 years (55.2%, 95% CI: 52.0–58.4%) than the older groups (aged 35–54 years: 61.9%, 95% CI: 59.2–64.7%; aged ≥ 55 years: 63.8%, 95% CI: 61.3–66.4%), and participants of lowest and highest educational attainment (primary or below: 57.5%, 95% CI: 52.8–62.2%; secondary: 63.9%, 95% CI: 61.5–66.3%; tertiary or above: 59.0%, 95% CI: 56.5–61.4%). After adjusting for sex, age and educational attainment and the prosocial-priming condition, low general vaccine confidence was strongly associated with markedly lower COVID-19 vaccine acceptance rates (low vaccine confidence: 11.6%, 95% CI: 6.8–16.4%; moderate vaccine confidence: 28.9%, 95% CI: 25.3–32.4%; and high vaccine confidence: 69.5%, 95% CI: 67.9–71.1%). The effect of prosocial priming on promoting vaccine acceptance was significantly greater for participants with low vaccine confidence ($B = 1.61$, $SE = 0.78$, $p = 0.038$, odds ratio (OR) = 5.00) (Fig. 3).

3.5. The modification effect of perceived personal risk

After adjusting for sex, age, educational attainment and prosocial-priming condition, perceived personal susceptibility to COVID-19 was not significantly associated with COVID-19 vaccine acceptance and there was no significant interaction effect between perceived personal susceptibility and prosocial priming on vaccine acceptance. Perceived greater severity from COVID-19 was associated with greater COVID-19 vaccine acceptance rates (very mild/mild: 53.0%, 95% CI: 48.2–57.7%; moderate: 63.9%, 95% CI: 60.8–67.0%; and serious/very serious: 64.7%, 95% CI: 62.8–66.7%). The effect of prosocial priming for promoting vaccine acceptance was

Table 1
Participants' characteristics.

	Round 1: Jun 23–26 (N = 511)	Round 2: Jul 6–10 (n = 509)	Round 3: Aug 3–7 (N = 519)	Round 4: Aug 31–Sep 4 (N = 508)	Round 5: Oct 5–10 (N = 1005)	Round 6: Nov 2–5 (N = 1004)	Total (N = 4055)	Effect size	Differences across survey (p-value) ^a
Sex (female)	53.2%	61.5%	57.6%	53.5%	55.2%	55.2%	55.8%	0.12	0.074
Age group (years)									
18–34	32.5%	26.8%	27.4%	29.0%	27.8%	25.5%	27.8%	0.19	<0.001
35–54	31.5%	37.1%	32.7%	32.8%	31.1%	26.6%	31.2%		
≥ 55	36.1%	36.1%	39.9%	38.2%	41.1%	47.9%	41.0%		
Educational attainment									
\leq Primary	9.1%	14.5%	10.3%	11.8%	13.9%	14.7%	12.9%	0.25	<0.001
Secondary	42.5%	42.1%	45.6%	46.1%	36.8%	44.4%	42.3%		
\geq Tertiary	48.3%	43.4%	44.1%	42.2%	49.3%	40.9%	44.8%		

Effect size w was calculated via the formula $w = \sqrt{\sum_{i=1}^m \frac{(p_0(i) - p_1(i))^2}{p_0(i)}}$ where $p_0(i)$ and $p_1(i)$ are the observed proportions in the i 'th category from the most recent census data of Hong Kong (2018) and the survey data, respectively.

^a P-values indicate differences in distributions of participants' sex, age and educational attainment across survey round based on Chi-square test.

Table 2
Percentages of accepting COVID-19 vaccines by prosocial priming condition across survey rounds.

Survey round	Model 1: without adjusting for vaccine confidence		Model 2: with adjustment for vaccine confidence	
	With prosocial priming	Without prosocial priming	With prosocial priming	Without prosocial priming
Round 1	68.4 (61.3–75.4) ^a	56.5 (49.8–63.2)	66.8 (60.0–73.4) ^a	57.3 (51.2–63.4)
Round 2	70.8 (64.9–76.7)	64.0 (57.6–70.4)	72.3 (66.8–77.8) ^a	62.6 (56.7–68.5)
Round 3	65.7 (59.0–71.8)	61.3 (54.1–67.9)	66.2 (60.2–72.2)	60.8 (54.2–67.4)
Round 4	61.6 (54.8–68.0) ^a	52.0 (45.2–58.7)	62.5 (56.3–68.7) ^a	50.9 (44.5–57.3)
Round 5	65.3 (60.3–69.9) ^a	56.7 (51.7–61.6)	65.9 (61.5–70.2) ^b	56.5 (51.9–61.1)
Round 6	59.4 (54.4–64.1)	53.3 (48.4–58.2)	60.2 (55.9–64.5) ^a	52.6 (48.2–56.9)
Overall	64.5 (62.1–66.9) ^c	56.7 (54.3–59.2)	65.1 (62.9–67.3) ^c	56.2 (54.0–58.4)

All values were percentages. The values within parentheses were the 95% confidence intervals of vaccine acceptance rates. ^a p-value < 0.05, ^b p-value < 0.01, and ^c p < 0.001, indicating differences by prosocial priming condition.

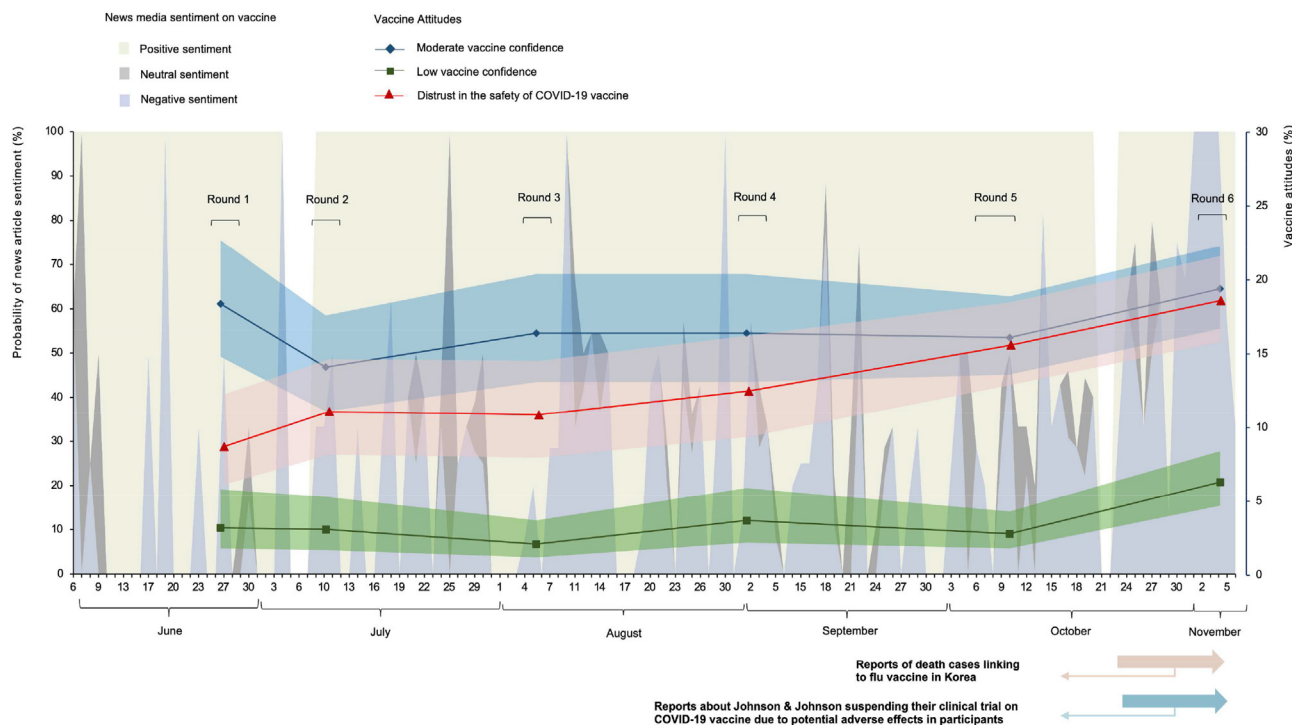


Fig. 2. Changes of vaccine confidence, distrust in the safety of COVID-19 vaccine, and news media sentiments on vaccine across survey rounds.

significantly greater for participants who perceived severity from COVID-19 to be very mild or mild ($B = 0.52$, $SE = 0.22$, $p = 0.020$, $OR = 1.68$) (Fig. 4).

Repeating all the above analyses by treating the “unsure” responses as missing data did not change the conclusion of each hypothesis.

4. Discussion

Our study suggests that prosocial priming can significantly increase public acceptance of COVID-19 vaccines. The effect of our prosocial priming may be different from introducing herd immunity which depends on people’s comprehension and memorization of the herd immunity information [5]. Instead, the prosocial priming in our study may activate a more heuristic and affective process that enables quick decision making [12,30,44]. Prosocial framing may evoke positive emotional responses to the promoted behaviours such as willingness to self-isolate during the pandemic because it links the behaviours to altruism and empathy with others and thereby increase prosocial behaviours [18]. This indicates that prosocial priming could be more acceptable compared with fear appeals [13] and thereby should be con-

sidered in current COVID-19 vaccine advocacy. COVID-19 vaccine acceptance rates in the condition of no prosocial priming are generally lower than that reported by the earlier global survey [27]. This is possibly because the global survey assessed COVID-19 vaccine acceptance with prior priming information of “if a COVID-19 vaccine is proven safe and effective” [27] whereas this prior information was not included in our question assessing COVID-19 vaccine acceptance. Other possible reasons include the changes in perceived risk of COVID-19 and COVID-19 vaccines over time. However, it should be noted that our study was different from the study conducted by Lazarus and others [27] because our study focused on examining the effect of prosocial priming on COVID-19 vaccine acceptance.

Around 20% of the participants had low or moderate vaccine confidence even when the pandemic was relatively severe in the community. This population can potentially become more sizeable if vaccine sentiment in news media becomes negative, posing challenge for the achievement of herd immunity through vaccination [17]. Negative information about vaccines from news media can be quickly spread through social media which further amplifies its impact on vaccine confidence [31,36]. It should be noted that our sentiment analysis included not only news about COVID-19

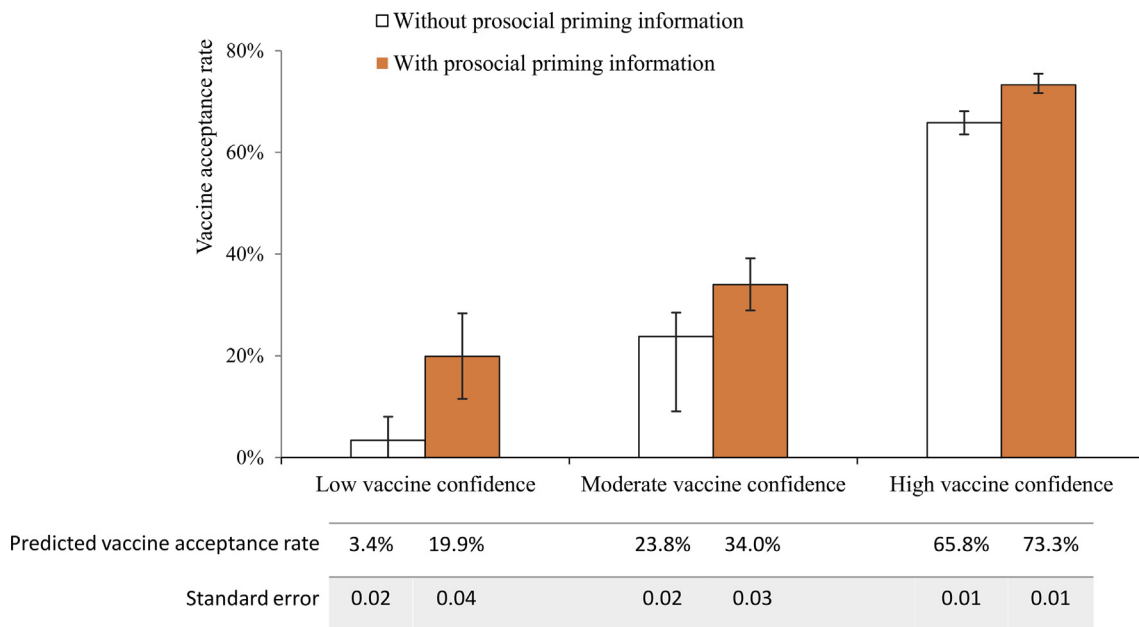


Fig. 3. Acceptance rate of a COVID-19 vaccine by prosocial-priming condition and level of general vaccine confidence.

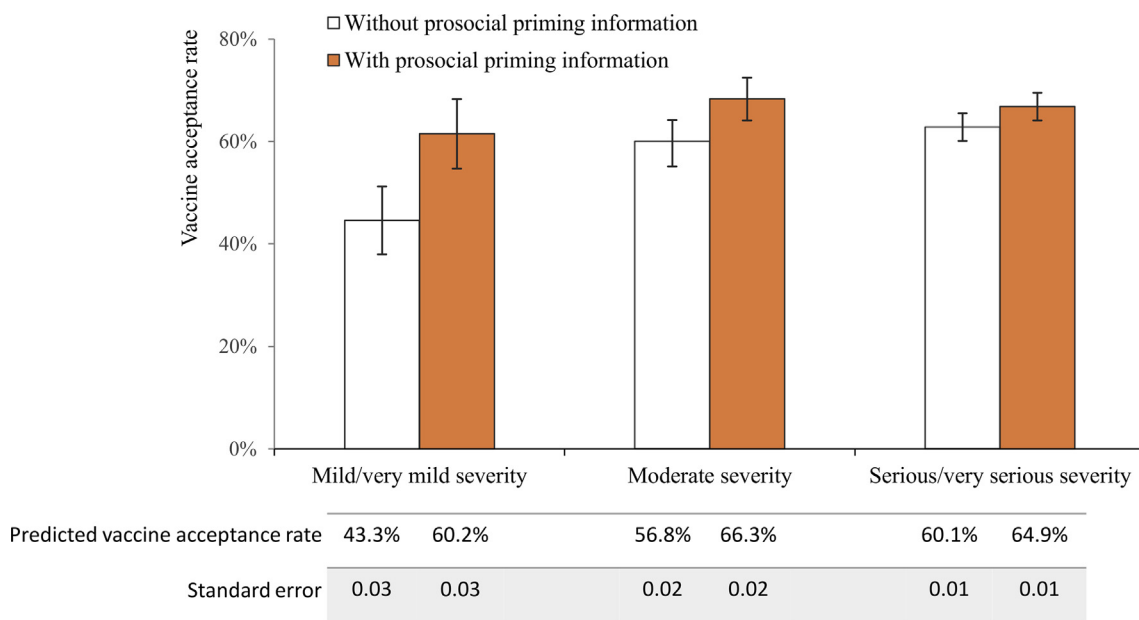


Fig. 4. Acceptance rate of a COVID-19 vaccine by prosocial-priming condition and level of perceived severity of COVID-19.

vaccines but also other vaccines. This indicates decline in general vaccine confidence rather than mere confidence in COVID-19 vaccines [38]. Timely response to negative news about vaccines from health authorities and health professional is important to counteract the effects. Current approaches for addressing vaccine confidence or hesitancy tend to be educational and informational and mostly unsuccessful [21,33,34] with few exceptions [15]. Our study found a greater positive effect of prosocial priming on COVID-19 vaccine acceptance among participants of low general vaccine confidence, indicating that prosocial priming can be a promising and simple strategy to help overcome vaccine hesitancy to achieve greater vaccine acceptance rates.

The effect of prosocial priming on vaccine acceptance is greater for individuals perceiving lower personal risk from the pandemic,

indicating that prosocial motivation rather than personal protection drives vaccination decision-making when the pandemic is perceived to be relatively mild. This finding has important implication for promoting acceptance of a vaccine when personal risk from infection is perceived to be mild but the socio-economic impact is tremendous where appealing for individual protection may miss the point [4]. Prosocial vaccination advocacy can also be important for promoting vaccine acceptance to prevent pandemic resurgence if the pandemic appears to be waning by the time vaccines are available, an important reason for the low uptake rates of the 2009 influenza A/H1N1 vaccines [7,29,39]. Prosocial priming may be more effective if the community benefits are constructed based on visible suffering of the community which can increase the target audience’s perceived relevance of expected benefits to their

own community. The effect may be generalized to individual actions for tackling global health problems such as climate change for which the impacts are perceived to be more distant [42]. However, this speculation awaits testing in future studies.

Our study has several limitations. First, the prosocial priming information was read by several interviewers who were also responsible for collecting data on vaccination intention and other data. This may introduce bias due to data collectors' awareness of the difference in the question. Nevertheless, standard training was provided for interviewers to standardize delivery of prosocial information and minimize biases during data collection. Second, the prosocial-priming effect could be partly due to social desirability bias. However, all participants were reassured that all data collected would be anonymous and the interviewers were trained to respect different opinions of the participants to minimize social desirability bias. It was also possible that participants who responded to the survey would be those who had greater social responsibility and thereby our study may overestimate the effect of prosocial priming for the target population. We were not able to compare the differences between respondents and non-respondents because all subjects were randomly recruited, and most non-respondents refused to participate in the study without giving reasons. Despite, cooperation rate of this survey was similar to previous telephone surveys on other health topics [46,48]. Third, a comparison group merely stating individual benefits of COVID-19 vaccination was missing because including one more comparison group would require a greater sample size in each survey round. Fourth, although participants in each survey round were comparable to the Hong Kong adult population in terms of sex, age and educational distributions, their age and educational distributions were significantly different across survey rounds. This may somewhat affect the comparability of the priming effects on vaccine acceptance across survey rounds. Therefore, we had weighted participants' vaccine acceptance rates by priming condition to the sex and age distribution of the census data to increase the comparability of results across survey rounds. Our media sentiment analysis on vaccines only included data from main newspapers of Hong Kong rather than the data from social media which has become an increasingly important health information source globally. However, Hong Kong general population predominately relies on local Chinese language newspapers for health information [22,45]. This study was conducted before COVID-19 vaccines were available and we were not able to follow-up our participants to examine the effect of prosocial information on actual vaccination uptake. Furthermore, our study was conducted in Hong Kong, an Asian city with dual cultural values of both collectivism and individualism [28]. Previous study indicated that the effect of emphasizing the social benefits of vaccination for promoting acceptance of a hypothetical vaccine was greater for participants from western countries than those from eastern countries [5]. Repeating this study in a predominantly individualistic country such as the USA or UK should be illuminating. Finally, prosocial priming was given through an introductory scenario before asking participants about their intention to receive COVID-19 vaccines. We assume that this minimal cue can activate participants' mental association of vaccination with social benefits and thereby increase prosocial behaviours. However, the potential psychological mechanisms await further testing. We are also unsure about how long the effect of a subtle cue on vaccine acceptance would last. If the effect of such prosocial priming is temporary, the priming message may be more useful when it is provided at the time when the vaccination service is immediately available.

In summary, prosocial priming was effective for promoting intention to accept a COVID-19 vaccine and the effect was significantly greater among participants with low vaccine confidence and those who perceived the pandemic to be mild or very mild for

themselves. Prosocial priming should be an effective strategy to help at least partly overcome vaccine hesitancy in the advocacy for taking vaccination against COVID-19. As general vaccine confidence and trust in COVID-19 vaccine safety could decline with more frequent reports of negative vaccine news, timely response to negative news about vaccines is important to mitigate the impact of negative media sentiments on vaccine hesitancy.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: [BJC consults for AstraZeneca, GSK, Moderna, Pfizer, Roche and Sanofi Pasteur. All authors declare no conflict of interests.]

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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.2022.01.031>.

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