

Supplemental material

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Text S1: Study Protocol (page 2-11)

Registration number: UMIN Clinical Trial Registry (identifier UMIN000045747)

Ethical application status: Approved from Kanto Central Hospital

Type of registration: Prospectively registered

Project title

Effect of a Mobile App Chatbot and an Interactive Small Group Webinar on COVID-19 Vaccine Intention and Confidence in Japan: A Randomized Clinical Trial

Background

A survey conducted in fifteen countries in January 2021 found that intent to take a COVID-19 vaccine was lower in Japan than in other countries: 36% of Japanese adults strongly or somewhat disagreed about getting a COVID-19 vaccine.¹ However, prior to the COVID-19 pandemic, Japan already had one of the world's highest vaccine hesitancy rates.² Japan also has a long history of public uncertainty regarding vaccines. For example, the Human Papillomavirus (HPV) vaccination rate among adolescent girls fell from over 70% to less than 1% following public concerns about possible vaccine adverse events.³

Our research aims to understand how a chatbot and online webinars could be used to address vaccine hesitancy among those ages 20 (the legal age) and older in Japan. Our research targets Japan because public concerns about COVID-19 vaccines could exacerbate the general mistrust of vaccines in Japan. Furthermore, research on COVID-19 vaccine hesitancy has focused on the United States and Europe, and thus geographic gaps in evidence exist regarding the effect of social media on COVID-19 vaccine intention. The current effort to address COVID-19 vaccine hesitancy in Japan primarily provides scientific information via government websites. However, there are limitations to this approach because information presented this way is typically too formal, not user-friendly, and not individualized. Therefore, addressing COVID-19 vaccine hesitancy requires more innovative solutions.

Vaccine hesitancy could be associated with a lack of scientific information or with the emotions underlying vaccine decision-making.⁴ We will provide tailored information based on

individuals' concerns and feelings. We will not simply spread general information to the public because we believe that addressing individuals' concerns reduces negative sentiments about vaccines. This is why we developed a free chatbot to provide COVID-19 vaccines information via text messages.⁵ The chatbot is a user-friendly platform for people to access vaccine information that they would like to know. People can select a question to ask from menu options in the chatbot, and they can get tailored information based on their concerns and interests. We previously published a cross-sectional study investigating the association between the use of this chatbot in a popular messenger app and vaccine intention for COVID-19 in Japan.⁵ Though this study demonstrated the potential usefulness of a social media-based chatbot to reduce vaccine hesitancy, this study was subject to multiple design limitations because the study was cross-sectional without a comparison group. Therefore, it had both internal (i.e., recall bias, interview bias) and external validity issues, and the association between chatbot use and vaccine intention could not be evaluated clearly.

We also need to create more opportunities for interactions between the public and the medical community to better understand people's emotions. The webinar will offer a platform where a health expert can promptly address an individual's concerns about COVID-19 vaccines. It will also provide a forum for an expert to listen to and understand what people are really concerned about, enabling a dialogue to address and manage people's negative emotions about COVID-19 vaccines.

Previous studies indicated the potential of online interventions to increase vaccine intention by providing accurate information about vaccines and diseases and by improving public perception of vaccines' benefits. For example, a randomized controlled study published by Glanz et al. in 2017 demonstrated that mothers presented with vaccine information on social media during their pregnancy were more likely to vaccinate their infants on time.⁶ However, a recent study published by Othman et al. in 2022 showed that just using social media was not directly associated with willingness to receive a COVID-19 vaccination.⁷ How online or social media-based interventions can be utilized to increase vaccine intention in Japan is not well-known, especially for COVID-19.

Aims

We aim to investigate whether a social media-based chatbot and webinars affect COVID-19 vaccine intention and vaccine confidence among those who are hesitant to be vaccinated against COVID-19 and to examine which online interventions (a chatbot or webinars) are more effective at increasing COVID-19 vaccine intention and vaccine confidence.

Study design

This will be a three-arm randomized controlled trial:

- a) The control group
- b) The chatbot group
- c) The webinar group

Study participants

Study participants will be recruited from the panel of a Japanese Internet research service company (NTTCom Online Marketing Solutions Corporation), which has approximately 120 million registered individuals as of October 2021. The company will send a screening survey to randomly selected persons depending on the sample size calculation (see details below). The screening survey will include the following five questions: (1) “How old are you?”; (2) “Have you received a COVID-19 vaccine?”; (3) “Do you intend to be vaccinated?” (with answer options of “Yes”, “Not sure but leaning towards Yes”, “Not sure but leaning towards No”, and “No”); (4) “Do you have LINE (one of the most popular messenger apps in Japan) installed on your mobile phone? If not, are you willing to download LINE to participate in this study?”; and, (5) “Are you capable of using Zoom (a videoconferencing app) for webinars?”. Eligibility criteria are: (1’) those ages 20 and older, (2’) those who have never received a COVID-19 vaccine, (3’) those who select an answer other than “Yes” to question #3, (4’) those who are willing to use LINE, and (5’) those who are willing to use Zoom. The questionnaires will be placed in a secured section of a website, and persons who consent electronically receive the link to the questionnaires. Monetary incentives will be given as follows: \$10 for those in the control group who complete the pre- and post-survey, \$15 for those who use the chatbot at least once and complete the pre- and post-survey, and \$30 for those who attend at least one of 14 webinars (at least more than 15 minutes) and complete pre- and post-survey.

Interventions

Intervention with LINE chatbot (the chatbot group)

LINE is a free messenger app available on electronic devices, such as smartphones, tablets, and personal computers. LINE users can exchange texts, images, videos, and audio. LINE is the most popular messenger app in Japan; about 86 million people in Japan (roughly two-thirds of the population) use this messenger app.⁸ We created a chatbot in LINE to answer COVID-19 vaccine frequently asked questions (FAQs) via text messages. To generate the

chatbot, we first searched for COVID-19 vaccine FAQs using Japanese government websites and the United States Centers for Disease Control and Prevention website.^{9 10} Approximately two hundred questions that we thought were important were selected. We then composed our corresponding answers to these two hundred questions and included them in the chatbot. The two hundred questions were then classified into seven categories: (1) what we should know before vaccination; (2) what we should know on the day of vaccination; (3) what we should know after vaccination; (4) eligibility; (5) effectiveness; (6) adverse effects; and, (7) questions related to age, comorbidities, allergies, medications, pregnancy, or breastfeeding. We also prepared two additional categories: (8) link to the Japanese government's website; and, (9) link to inquiry. Our chatbot works as follows: (1) users select one of the seven categories that they would like to know the answer to; (2) the chatbot responds with more specific questions in the selected category; (3) users choose the specific items that they would like to know more about; (4) the chatbot provides detailed information; (5) users may also search questions by typing in keywords; and (6) the chatbot shows potential questions that include the keywords. Study participants assigned to the chatbot group first receive an email that explains how to download LINE and the chatbot, provides a direct link for these downloads, and covers how to use the chatbot with a five-minute YouTube video (<https://youtu.be/nJBTHaXapQ8>). This YouTube video explains in detail the steps to download and use it. In addition, we plan to track who downloads the chatbot and how frequently each FAQ is accessed in the chatbot during the study period to determine which participants we should include for the final analysis.

Intervention with interactive webinars

We plan to conduct a total of 14 webinars via the Zoom videoconferencing application between November 16 and December 7, 2021. Each seminar will be held on Tuesdays and Fridays at 10 a.m. and 8 p.m. so that the study participants can choose suitable dates and times according to their availability. We will ask them to attend at least one webinar for at least 15 minutes. Participants can participate in more than one webinar if they are interested. They are required to choose their preferred date and time for the webinar and to register in advance on the website (this temporary website that we create will host 14 different links to the webinar registrations). Each webinar will be limited to a maximum of 40 participants. For those who have registered, reminder emails will be sent to them 24 hours and 1 hour before the webinar using an automated reminder system in Zoom. We will send an email to the webinar group participants four times (the initial instructions email and three reminders) to encourage them to register for at least one of 14 webinars. Each webinar will include a brief lecture about COVID

vaccines presented by physicians (10 minutes) using PowerPoint slides, followed by Q&A sessions (additional 20 minutes at least and up to 50 minutes for those who stay and ask more questions). The lecture will include the history of vaccines, the necessity and the efficacy of the COVID vaccine, and the short- and long-term adverse events. Participants will be engaged to ask questions throughout a webinar through the Q&A chat in Zoom, and questions from participants will be collected before and during the webinar as well. Attendees will be able to submit questions using their names or anonymously. Three of seven Japanese physicians (T.K, Y.Y, H.T, K.H, Y.N, K.T, and K.I) are required to attend each webinar as presenters, and the webinars will be conducted in the Japanese language only. Each webinar will include three physicians, one moderator, and one office administrator. Physicians will answer all questions submitted upon registration through Zoom and during webinars. We will track who registered and participated in each webinar. Those who stay on a webinar for less than 15 minutes (out of 30 minutes) will not be counted as attending a webinar and will not be included in the final analysis.

The baseline survey and post-intervention survey

Pre-intervention survey:

The pre-survey includes a total of 30 questions. To quantify attitudes and beliefs regarding COVID-19 vaccines, we will use Vaccine Confidence Index (VCI). A previous study demonstrated, among multiple factors influencing vaccine decisions, key drivers of public confidence in vaccines were trust in the importance, safety, and effectiveness of vaccines, and compatibility of vaccination with religious beliefs.¹¹ The VCI survey tool was developed in 2015 and has been utilized in multiple vaccine studies.¹² VCI includes the four vaccine confidence statements: "Vaccines are important for children to have"; "Overall, I think vaccines are safe"; "Overall, I think vaccines are effective"; and, "Vaccines are compatible with my religious beliefs". We will not use the last statement about religious beliefs for our study because this statement does not fit customs in Japan where more than 80% of people practice no religion or Buddhism. We will also include survey items used in similar studies and will add our own questions.¹³ Our other survey items ask for age, sex, geographic location, educational attainment, employment status, marital status, whether they work in a healthcare setting, annual household income, presence of chronic diseases identified as risk factors for severe COVID-19 by the Japanese government⁹, history of receiving the influenza vaccine in the previous season, history of COVID-19 infection, history of any side effects from any previous vaccination, and COVID-19 vaccine intention for their children if they have a child. Geographic locations will be combined

using the following categories: Hokkaido, Tohoku, Kanto (e.g., Tokyo), Chubu, Kansai (e.g., Osaka), Kinki, Chugoku, Shikoku, Kyushu regions, and outside of Japan.¹⁴ In addition, we will ask questions about personal experiences with social media and COVID-19 vaccine information. These questions include which social network the participants use most to obtain COVID-19 vaccine information, which social media they trust most, how long they use social media per day, etc. (see details in appendix S2)

Persons who answer the pre-survey will be randomly assigned to one of the following three groups: (i) a group with no exposure to the LINE chatbot nor a webinar (i.e., the control group), (ii) a group with exposure to the mobile app chatbot (i.e., the chatbot group), and (iii) a group with exposure to online interactive seminars (i.e., the webinar group). Instructions for each intervention will be sent to the three groups on November 15, 2021.

We created five different post-surveys that vary based on the assigned group and whether the study participants actually used the chatbot or attended the webinar. All three groups will be asked about (1) whether they received a COVID-19 vaccine since completing the pre-survey, (2) vaccine intention, and (3) VCI for the safety, importance, and effectiveness. We will also ask for feedback on the interventions for the chatbot group and the webinar group. The post-survey will be conducted from December 2021 through January 2022.

Sample size calculation

A previous study in France investigating the impact of an interactive web tool on patients with COVID-19 vaccine hesitancy showed that 8% of 1200 patients accepted COVID-19 vaccination after their intervention.¹⁵ We assumed that the estimated proportion of Vaccine Intention (VI) in the intervention group after the intervention will be 10% and that the proportion of VI in the control group will remain zero. For achieving an 80% power at a 5% level of significance with equal allocation, a dropout rate at 40%, and a superiority margin of 5%, the calculated sample size for each arm is 371.

Statistical analysis

Participant characteristics will be summarized using frequencies and percentages. For two group comparisons, the Chi-squared test or Fisher's exact test will be used for categorical variables, and the U-Mann Whitney test will be used for continuous variables. For three group comparisons, the Chi-squared test will be used for categorical variables.

Primary outcomes are Vaccine Intention (VI) and VCI. VI is measured by the proportion of those who received the COVID-19 vaccine since the pre-survey, and those who have not

received the COVID-19 vaccine but answered “Yes” in the post-survey to the question “Do you intend to be vaccinated against COVID-19?” The difference in the proportion (post-intervention – pre-intervention) of vaccine intention will be assessed by Chi-square test. Vaccine confidence is quantified using Vaccine Confidence Index.¹¹ Changes in vaccine confidence across arms will be compared using a mixed effects logistic regression model by comparing proportions of participants who responded “strongly agree” or “tend to agree” to these specific questions on vaccine confidence. We will use R version 4.0.4 (R Development Core Team, Vienna) for statistical analysis. A p-value of 0.05 will be considered statistically significant.

Ethical approval

IRB was obtained in October 2021 from Kanto Central Hospital. Consent will be electronically obtained from all study participants.

Recruitment

September 2021: We contacted a Japanese Internet research service company (NTTCom Online Marketing Solutions Corporation).

October 2021: The screening survey was sent to 700,000 randomly selected persons in the panel on October 20, 2021 with the following five questions: (1) “How old are you?”; (2) “Have you received a COVID-19 vaccine?”; (3) “Do you intend to be vaccinated?” (with answer options of “Yes”, “Not sure but leaning towards Yes”, “Not sure but leaning towards No”, and “No”); (4) “Do you have LINE (one of the most popular messenger apps in Japan) installed on your mobile phone? If not, are you willing to download LINE to participate in this study?”; and, (5) “Are you capable of using Zoom (a videoconferencing app) for webinars?”.

November 5, 2021 - November 10, 2021: The study details and the consent form were sent through NTTCom to the possibly eligible research panel of NTTCom. Once the consent form was obtained electronically, they were sent the link to the questionnaires placed in a secured section of a website. A total of 99,965 persons responded to the screening questions between November 5 to November 10, 2021. Of them, 15,398 (15.4%) persons had not received the vaccine yet, of which 13,314 (86.5%) did not intend to be vaccinated. Among 13,314 eligible persons, 1,158 agreed to participate in the study, completed the pre-survey, and were randomly assigned to 3 different groups: 386 in the control group, 386 in the chatbot, and 386 in the webinar group.

Project summary

COVID-19 vaccination started in February 2021 in Japan, and the coverage is 26.4% of all populations in Japan as of 27 July 2021 (<https://ourworldindata.org/covid-vaccinations>).

While the reasons behind the slow rollout might be mostly logistical issues, they are also likely rooted in public vaccine hesitancy.

To better understand how social media could be used to address vaccine hesitancy in Japan, we will conduct a randomized controlled trial (RCT) using social media interventions to increase the intention to receive COVID-19 vaccines (vaccine intention) and confidence in COVID-19 vaccines (vaccine confidence), targeting those ages 20 and older in Japan. Persons who meet the eligibility criteria will be randomized into the following groups: (i) a control group (with no exposure to the chatbot nor a webinar, (ii) a group with a free LINE chatbot providing information on COVID-19 vaccines; (iii) a group with free webinars where a health professional interactively provides participants with information on COVID-19 vaccines. Groups (ii) and (iii) will be provided with the assigned interventions over 5-6 weeks. All three groups will complete a pre- and post-survey online to investigate vaccine intention and confidence.

We will analyze how the LINE chatbot and webinars affect vaccine intention and vaccine confidence after these interventions. We will also compare the effectiveness of the LINE chatbot with that of a webinar to see which format (unidirectional vs. bidirectional) addresses vaccine hesitancy in Japan more effectively.

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Text S2: Pre-survey

1. What is your sex?
 - a. Male
 - b. Female
 - c. Others (please state) _____
 - d. Prefer not to say

2. How old are you?
Select a number (20-120)

3. What is your highest level of education?
 - a. Elementary school or secondary school
 - b. High school
 - c. Professional or vocational qualification
 - d. Bachelor's degree
 - e. Master's degree
 - f. Doctoral degree

4. Where do you live?
< Japan-specific answer options >
Select from 47 prefectures in Japan + Others (please state) _____

5. Are you employed currently?
 - a. Full-time
 - b. Part-time
 - c. Unemployed
 - d. Retired
 - e. Student
 - f. Others (please state) _____

6. Do you work in a healthcare setting currently?
 - a. Yes, I work in a healthcare setting as a medical doctor

- b. Yes, I work in a healthcare setting as a health professional other than a medical doctor
 - c. No. I do NOT work in a healthcare setting.
7. Do you have any of the following illnesses/diseases? (Select all that apply)
- a. Chronic respiratory disease
 - b. Chronic heart disease (including hypertension)
 - c. Chronic kidney disease
 - d. Chronic liver disease (except for fatty liver or chronic hepatitis)
 - e. Diabetes treated with insulin or other oral medication, or diabetes with any complication
 - f. Blood disease (except for anemia)
 - g. Disease with immune suppression (including neoplasms, regardless of treatment)
 - h. Receiving treatment that may suppress the immune system (e.g. steroids)
 - i. Neurological or neuromuscular disease due to immune deficiency
 - j. Physical decline associated with a neurological disease or a neuromuscular disease (such as a respiratory disease)
 - k. Chromosomal abnormality
 - l. Severe psychosomatic disorder (overlapping severe physical disability and severe intellectual disability)
 - m. Depression/anxiety disorder
 - n. Sleep Apnea syndrome
 - o. Obesity (BMI over 30, which would typically be a person of 170cm height weighing 87kg, or 160cm height weighing 77kg)
 - p. No underlying health conditions
 - q. Others (please state) _____
8. Are you married?
- a. Married
 - b. Never married
 - c. Divorced
 - d. Widowed
 - e. Others (please state) _____

9. What is your income?
- Less than JPY 2 million
 - JPY 200 million < JPY 400 million
 - JPY 400 million < JPY 600 million
 - JPY 600 million < JPY 800 million
 - JPY 800 million or higher
10. Do you receive the influenza vaccine annually?
- Yes
 - No
 - Unsure
11. Have you ever been diagnosed (tested positive or diagnosed by doctor) with COVID-19?
- Yes
 - No
 - Unsure
12. Have you ever experienced a side effect or allergy after any vaccination?
- Yes
 - No
 - Unsure
13. To what degree do you agree with the following statement?
"Overall, I think COVID-19 vaccines are important."
- Strongly agree
 - Tend to agree
 - Do not know
 - Tend to disagree
 - Strongly disagree
14. To what degree do you agree with the following statement?
"Overall, I think COVID-19 vaccines are safe."
- Strongly agree

- b. Tend to agree
- c. Do not know
- d. Tend to disagree
- e. Strongly disagree

15. To what degree do you agree with the following statement?

"Overall, I think COVID-19 vaccines are effective."

- a. Strongly agree
- b. Tend to agree
- c. Do not know
- d. Tend to disagree
- e. Strongly disagree

16. How many children do you have in each of the following age ranges? If you do not have any children, please enter "0" for each range.

- a. Age 0-5: 0-20 (dropdown list to select the number of children)
- b. Age 6-11: 0-20
- c. Age 12-18: 0-20
- d. Age 19 or above: 0-20

17. (If you have at least one child) Do you want to have your child/children vaccinated against COVID-19, if it is indicated and available for them?

- a. Yes, definitely.
- b. Unsure, but leaning towards yes.
- c. Unsure, but leaning towards no.
- d. No, definitely not.
- e. No, I do not have any children.

18. Which of the following, if any, might convince you to receive a COVID-19 vaccine? (can choose multiple)

- a. Recommendation from a friend
- b. Recommendation from a family member
- c. Recommendation from a politician I like
- d. Recommendation from a celebrity I like

- e. Recommendation from the Government
- f. Recommendation from a doctor or other healthcare worker
- g. Others (please state) _____
- h. Do not know

19. Have you encouraged any of the following to get a COVID-19 vaccine? (can choose multiple)

- a. Spouse
- b. Parent
- c. Sibling
- d. Son or daughter
- e. Friend
- f. Colleague
- g. Others (please state) _____
- h. I have not encouraged anyone to get a COVID-19 vaccine

20. Which of the following emotions have you experienced in the past two weeks? (can choose multiple)

- a. Fear
- b. Joy
- c. Anger
- d. Hope
- e. Anxiety
- f. Empathy
- g. Grief
- h. Trust
- i. Others _____ [Free response]

21. To what degree do you agree with the following statements? Please place a checkmark in the box that applies to you.

Statement	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I may get a COVID-19 infection within the next 6 months					
COVID-19 is a serious disease					
I believe that getting a COVID-19 vaccine will ease my anxiety					
I do not need to get a COVID-19 vaccine because I wash my hands frequently with soap or sanitizer, which can help prevent the spread of COVID-19					
I do not need to get a COVID-19 vaccine because I practice social distancing, which can help prevent the spread of COVID-19					
I believe that vaccines can help					

control the spread of COVID-19					
It is easy to find relevant information on COVID-19 vaccines					

22. To what degree do you agree with the following statement? Please place a checkmark in the box that applies to you.

Statement	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I will get a COVID-19 vaccine if many others have received it.					
I will get a COVID-19 vaccine if a COVID-19 vaccine certificate or passport is required for work or school.					
I will get a COVID-19 vaccine if a COVID-19 vaccine certificate					

or passport is required for travel, social events, or dine-in.					
COVID-19 vaccination should be compulsory for all citizens in Japan					

23. In the past month, on average, how much time per day do you spend actively using social media?

- a. None
- b. Less than 10 minutes per day
- c. More than 10–less than 30 minutes per day
- d. More than 30–less than 60 minutes per day
- e. More than 1 hour–less than 2 hours per day
- f. More than 2 hours–less than 3 hours per day
- g. More than 3 hours per day

24. In the past month, which social media platforms have you used? (Please choose all that apply.)

- a. Facebook
- b. Twitter
- c. YouTube
- d. WhatsApp
- e. LINE
- f. Facebook Messenger
- g. Instagram
- h. TikTok
- i. LinkedIn
- j. Others (please state) _____

25. In the past month, from which of these social media platforms did you receive information regarding COVID-19 vaccines? (Please choose all that apply.)

- a. Facebook
- b. Twitter
- c. YouTube
- d. WhatsApp
- e. LINE
- f. Facebook Messenger
- g. Instagram
- h. TikTok
- i. LinkedIn
- j. Others (please state) _____

26. Please rank your TOP THREE sources of information for learning about COVID-19 vaccines in order of trust (Please only select and rank the top three information sources, with 1 being the most trusted).

Ranked first:

Ranked second:

Ranked third:

- a. National television (e.g. NHK)
- b. Radio
- c. International television (e.g. CNN, BBC)
- d. Newspapers or magazines
- e. Social media
- f. National public health authorities (e.g. Ministry of Health, Labour and Welfare)
- g. Healthcare workers
- h. Religious leaders
- i. International health authorities (e.g. World Health Organization)
- j. Community organizations
- k. Scientists
- l. Government websites
- m. The internet or search engines
- n. Family and friends

- o. Work, school, or college/university
- p. Do not know
- q. Others (please state) _____

27. Have you ever seen or heard any COVID-19-associated information on social media that might have persuaded you not to immunize yourself/your child/children against COVID-19?

- a. Yes (please give us an example [free response])
- b. No
- c. Do not know

28. Decide whether *you think the following statement is true or false.*

	True	Unsure	False
Genetic recombination technology is used in a COVID-19 vaccine to cause changes in genes (chromosomes) through vaccination			
Many people have died after getting the COVID-19 vaccines			
COVID-19 vaccination is associated with infertility and/or miscarriage			
COVID-19 vaccination causes COVID-19 infection to those who receive the vaccines and the people around them			
COVID-19 vaccines were approved without completing the normal clinical trials approval process			
The safety of COVID-19 vaccines has not been confirmed yet because the clinical trials are not completed yet			
In animal experiments, many animals died after getting the COVID-19 vaccines			

29. Please tell us briefly why you responded “Unsure, but leaning towards yes”, “Unsure, but leaning towards no”, or “No, definitely not” for the screening question* that “Do you want to receive a COVID-19 vaccine in the future”?

_____ [Free response]

*(For your reference, the screening question was the following):

Do you want to receive a COVID-19 vaccine in the future?

- a. Yes, definitely.
- b. Unsure, but leaning towards yes.
- c. Unsure, but leaning towards no.
- d. No, definitely not.

30. Please tell us briefly what would change your mind about a COVID-19 vaccine so that you get vaccinated?

_____ [Free response]

Text S3: Post-survey

1. Have you received a COVID-19 vaccine?
 - a. Yes
 - b. No

2. (For those who chose “a” for #1)
Please tell us briefly what influenced your decision about a COVID-19 vaccine and the reason why you got vaccinated against COVID-19?
_____ [Free response]

3. (For those who chose “b” for #1)
Do you want to receive a COVID-19 vaccine in the future?
 - a. Yes, definitely.
 - b. Unsure, but leaning towards yes.
 - c. Unsure, but leaning towards no.
 - d. No, definitely not.

4. (For those who chose “a” for #3)
Please tell us briefly what influenced your decision about a COVID-19 vaccine and the reason why you want to receive a COVID-19 vaccine?
_____ [Free response]

5. (For those who chose “b”, “c”, “d” for #3)
Please tell us briefly why you chose “the answer (b, c or d)” for #3?
_____ [Free response]

6. Would you choose to receive an annual booster against COVID-19 if it is recommended?
 - a. Yes, definitely.

- b. Unsure, but leaning towards yes.
 - f. Unsure, but leaning towards no.
 - g. No, definitely not.
7. How many children do you have in each of the following age ranges? If you do not have any children, please enter "0" for each range.
- a. Age 0-5: 0-20 (dropdown list to select the number of children)
 - b. Age 6-11: 0-20
 - c. Age 12-18: 0-20
 - d. Age 19 or above: 0-20
8. (if you have at least one child) Do you want to have your child/children vaccinated against COVID-19 if it is indicated and available for them?
- a. Yes, definitely.
 - b. Unsure, but leaning towards yes.
 - c. Unsure, but leaning towards no.
 - d. No, definitely not.
9. (if you have at least one child) Please tell us briefly why you chose "the answer for #8"?
- _____ [Free response]
10. To what degree do you agree with the following statement?
"Overall, I think COVID-19 vaccines are important"
- a. Strongly agree
 - b. Tend to agree
 - c. Do not know
 - d. Tend to disagree
 - e. Strongly disagree
11. To what degree do you agree with the following statement?
"Overall, I think COVID-19 vaccines are safe."

- a. Strongly agree
- b. Tend to agree
- c. Do not know
- d. Tend to disagree
- e. Strongly disagree
12. To what degree do you agree with the following statement?
"Overall, I think COVID-19 vaccines are effective."
- a. Strongly agree
- b. Tend to agree
- c. Do not know
- d. Tend to disagree
- e. Strongly disagree
13. Which of the following emotions have you experienced in the past two weeks? (can choose multiple)
- a. Fear
- b. Joy
- c. Anger
- d. Hope
- e. Anxiety
- f. Empathy
- g. Grief
- h. Trust
- i. Others_____ [Free response]
14. To what degree do you agree with the following statement? Please place a check mark in the box that applies to you.

	Strongly Agree	Agree	Neither agree nor disagree	Disagre e	Strongly disagree
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I may get a COVID-19 infection within the next 6 months					
COVID-19 is a serious disease					
I believe that getting a COVID-19 vaccine will ease my anxiety					
I do not need to get a COVID-19 vaccine because I wash hands frequently with soap or sanitizer, which can help prevent the spread of COVID-19					
I do not need to get a COVID-19 vaccine because I practice social distancing,					
I believe a vaccine can help control the spread of COVID-19					
It is easy to find relevant information on COVID-19 vaccines					

15. To what degree do you agree with the following statement? Please place a check mark in the box that applies to you.

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I will get a COVID-19 vaccine if many others have received it.					

I will get a COVID-19 vaccine if a COVID-19 vaccine certificate or passport is required for work or school.					
I will get a COVID-19 vaccine if a COVID-19 vaccine certificate or passport is required for travel, social events or dine-in.					
COVID-19 vaccination should be compulsory for all citizens in Japan					

16. Please rank your TOP THREE sources of information for learning about COVID-19 vaccines in order of trust (Please only select and rank the top three information sources, with 1 being the most trusted).

Ranked first:

Ranked second:

Ranked third:

- a. National television (e.g. NHK)
- b. Radio
- c. International television (e.g. CNN, BBC)
- d. Newspapers or magazines
- e. Social media
- f. Ministry of Health, Labour and Welfare
- g. Healthcare workers
- h. Religious leaders
- i. International health authorities (e.g. World Health Organization)
- j. Community organizations (e.g. local governments)
- k. Scientists
- l. Government websites
- m. The internet or search engines
- n. Family and friends
- o. Work, school, or college/university

p. Others (please state) _____

17. Decide whether *you think the following statement is true or false*. Please place a check mark in a box that applies to you.

	True	Unsure	False
Genetic recombination technology is used in a COVID-19 vaccine to cause changes in genes (chromosomes) through vaccination			
Many people have died after getting the COVID-19 vaccines			
COVID-19 vaccination is associated with infertility and/or miscarriage			
COVID-19 vaccination causes COVID-19 infection to those who receive the vaccines and people around them			
COVID-19 vaccines were approved without completing the normal clinical trials approval process			
The safety of COVID-19 vaccines has not been confirmed yet because the clinical trials are not completed yet			
In animal experiments, many animals died after getting the COVID-19 vaccines			

Questions 18-22 are only applicable to those who are assigned to either chatbot or webinar.

18. (For chatbot group) On which platform would this chatbot be most helpful?(Select all that apply)
- Ministry of Health, Labour and Welfare website
 - Health-related website operated by non-government
 - SMS on your mobile phone

- d. LINE
- e. WhatsApp
- f. Facebook Messenger
- g. Skype message
- h. Google Hangout
- i. Other _____ [free response]

(For webinar group) On which platform would this webinar be most helpful?

(Select all that apply)

- a. Zoom
- b. YouTube
- c. Skype
- d. Google Meet
- e. Teams
- f. Clubhouse
- g. Face-to-face settings
- h. Other _____ [free response]

19. What information were you seeking? (Check all that apply)
- 1. COVID-19 vaccine safety/side effects
 - 2. COVID-19 vaccine effectiveness
 - 3. How to receive a COVID-19 vaccine (e.g. whether you can choose the type of the vaccines, the length between first and second doses, etc.)
 - 4. What life is like after you receive a COVID-19 vaccine (e.g. wearing masks after vaccination, taking a bath or driving on the day when you receive a vaccine, etc.)
 - 5. Eligibility for COVID-19 vaccines
 - 6. COVID-19 vaccine boosters
 - 7. COVID-19 vaccines and pregnancy
 - 8. COVID-19 new variants
 - 9. Other _____ [free response]

20. To what degree do you agree with the following statement? Please place a check mark in the box that applies to you.

For chatbot-group

Statement	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Overall, the chatbot was helpful/informative					
It was easy to register for the chatbot					
The design of the chatbot was user-friendly					
It was helpful to be able to access the chatbot anytime and anywhere					
It was easy to find the information I was searching for in the chatbot					
The chatbot comprehensively covered many types of questions					
I am satisfied with the chatbot's answer(s) to my question(s)					

It was helpful that the sources of the information are specified for each answer					
I like the design of the chatbot (font, color, etc.)					
I intend to use the chatbot again					
I intend to recommend the chatbot to others					

For webinar-group

Statement	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Overall, the webinar was helpful/informative					
It was easy to register for the webinar					
The length of the webinar was long					
The length of the webinar was short					

I found the information I was searching for from the webinars					
I am satisfied with the webinars' answer(s) to my question(s)					
It was helpful to ask experts and get information in an interactive way					
I liked the group session format of the webinars (I prefer group sessions rather than one-on-one sessions)					
I intend to participate in the webinars again					
I intend to recommend the webinars to others					

21. What was most useful in the chatbot/webinar?

_____ Free response

22. Do you have suggestions to improve the chatbot/webinar?

_____ Free response

Figure S1. Corowa-kun's Consultation Room: a free messenger app chatbot, Japan

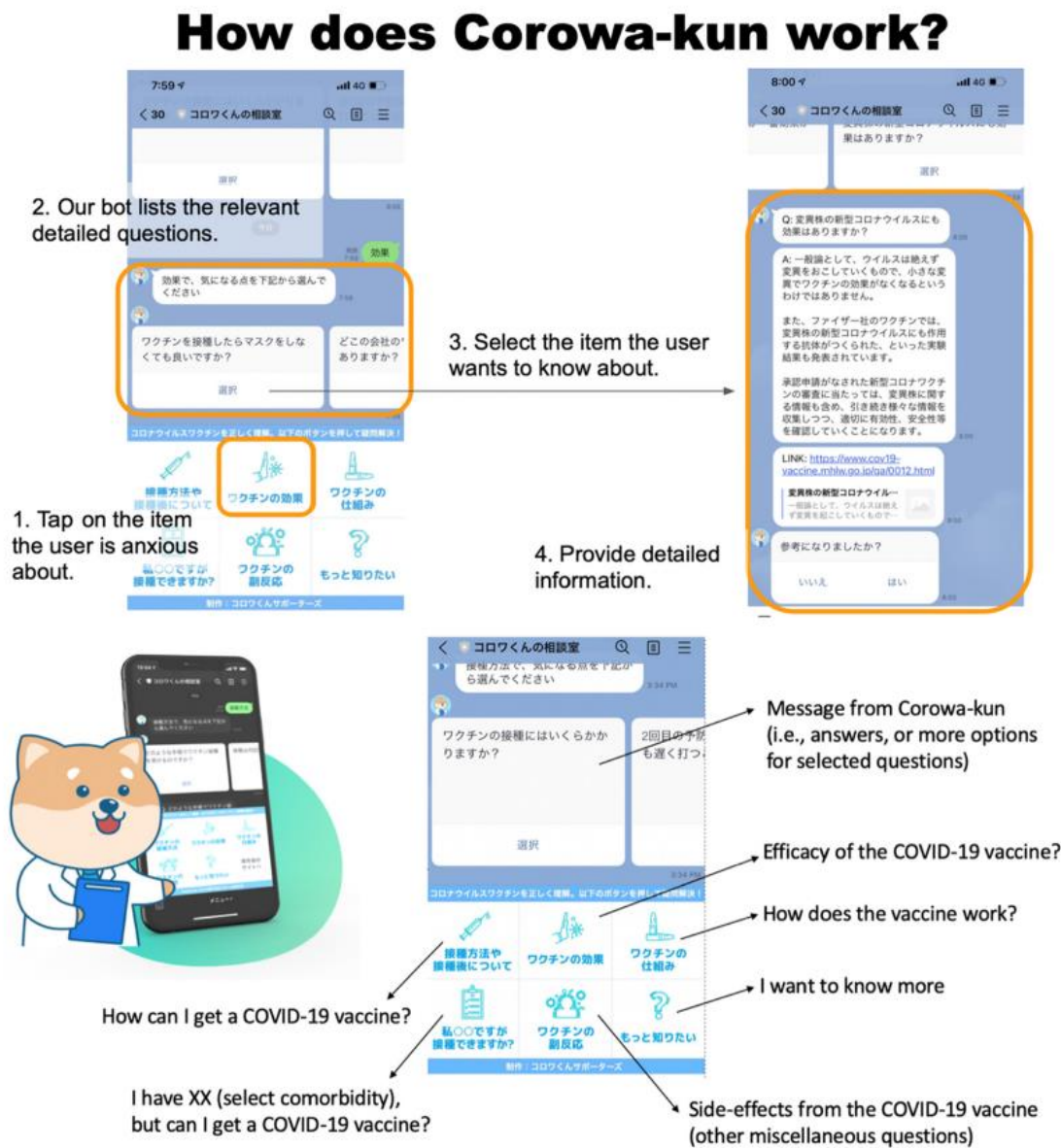


Table S1. Baseline participant characteristics and perceptions of COVID-19 vaccines by intervention groups.

All participants n=1158	Group 1 (control) n=386	Group 2 (chatbot) n=386	Group 3 (webinar) n=386
Characteristics			
Age (y), mean	44.7	45.8	46.2
Gender, % male	53.1	54.9	55.7
Education, %			
High school or less	28.5	26.7	32.9
Professional or vocational qualification	20.5	22.3	16.3
Bachelor's degree or above	51.0	51.0	50.8
Residential location, %			
Hokkaido	4.1	3.1	4.7
Tohoku	3.1	5.2	3.9
Kanto	44.3	47.4	44
Chubu	15.8	11.7	9.8
Kinki	18.9	18.7	24.1
Chugoku	5.7	3.4	4.7
Shikoku	0.8	1	2.1
Kysyu	7.3	9.6	6.7
Employment, %			
Full-time	56.2	52.6	53.1
Part-time	16.3	16.3	19.7
Unemployed	15.8	18.4	16.8
Retired	2.3	3.6	3.1
Students	0.8	1.0	0.5
Others	8.5	8.0	6.7
Healthcare worker, %	4.7	3.1	3.1
Marital status, %			
Married	54.1	47.2	48.7

Never married	39.6	40.7	39.4
Divorced	6.0	11.4	10.4
Widowed	0.3	0.5	1.6
Others	0.0	0.3	0.0
Income, %			
< JPY 200 mil	31.6	37.6	36.5
JPY 200-399 mil	29.0	26.4	25.6
JPY 400-599 mil	21.8	19.7	23.3
JPY 600-799 mil	8.5	6.2	8.8
≥ JPY 800 mil	9.1	10.1	5.7
Underlying health conditions, % ^b	5.4	3.6	4.7
Usually received flu vaccine, %	17.4	11.7	17.1
Diagnosed with COVID-19, %	2.6	2.3	1.3
Ever experienced a side effect or allergy after any vaccination, %			
Yes	9.1	7.8	10.1
No	86.0	85.2	82.6
Unsure	4.9	7.0	7.3
How many children of the following age range? (mean)			
0-5y	0.12	0.15	0.16
6-11y	0.13	0.13	0.13
12-18y	0.19	0.17	0.12
≥19y	0.34	0.41	0.40
Which might convince you to take a COVID-19 vaccine? (%)			
Recommendation from a friend	7.8	6.5	4.7
Recommendation from a family member	15.3	14.0	14.2
Recommendation from a politician that I like	0.8	0.5	0.0

Recommendation from a celebrity that I like	1.8	1.6	1.8
Recommendation from the Government	4.4	2.3	2.8
Recommendation from a doctor or other healthcare worker	28.2	22.5	21.2
Have you personally encouraged any of the following to take a COVID-19 vaccine? (%)			
Spouse	5.4	2.6	3.6
Parent	6.0	4.1	3.1
Sibling	0.0	0.3	1.3
Son or daughter	1.0	0.8	1.6
Friend	2.3	0.5	0.0
Colleague	1.6	0.3	0.3
I have not personally encouraged anyone to take a COVID-19 vaccine	87.3	92.5	92.5
Which of the following emotions have you experienced in the past two weeks? (%)			
Fear	16.3	15.8	15.8
Joy	49.7	51.3	48.4
Anger	42.2	42.2	38.1
Hope	27.7	28.0	25.4
Anxiety	65.0	64.0	63.7
Empathy	28.2	33.2	33.4
Grief	27.5	29.5	30.3
Trust	21.5	19.9	19.4
I may get COVID-19 infection within the next 6 months, %			
Strongly agree	1.8	1.0	2.1
Agree	6.7	6.7	5.7
Neither agree nor disagree	42.5	44.6	40.2
Disagree	25.9	24.9	26.4
Strongly disagree	23.1	22.8	25.6

COVID-19 is a serious disease, %			
Strongly agree	14.0	17.1	16.8
Agree	29.5	28.0	31.1
Neither agree nor disagree	31.3	30.3	25.4
Disagree	14.5	13.0	14.8
Strongly disagree	10.6	11.7	11.9
I believe that getting a COVID-19 vaccine will ease my anxiety, %			
Strongly agree	0.8	1.3	1.3
Agree	7.5	7.0	7.8
Neither agree nor disagree	34.5	32.9	29.8
Disagree	23.6	26.2	25.6
Strongly disagree	33.7	32.6	35.5
I do not need to take a COVID-19 vaccine because I wash hands frequently with soap or sanitizer, which can help prevent the spread of COVID-19, %			
Strongly agree	8.0	5.7	7.0
Agree	14.2	16.6	12.2
Neither agree nor disagree	50.8	51	48.7
Disagree	19.7	18.7	20.2
Strongly disagree	7.3	8.0	11.9
I do not need to take a COVID-19 vaccine because I practice social distancing, which can help prevent the spread of COVID-19, %			
Strongly agree	7.3	3.9	6.5
Agree	12.4	16.1	13.0
Neither agree nor disagree	54.9	53.4	47.2
Disagree	18.4	18.9	21.8
Strongly disagree	7.0	7.8	11.7

I believe a vaccine can help control the spread of COVID-19, %			
Strongly agree	5.4	5.4	3.4
Agree	30.8	29.0	35.8
Neither agree nor disagree	39.6	41.5	36
Disagree	11.7	9.8	12.4
Strongly disagree	12.4	14.2	12.4
It is easy to find relevant information on COVID-19 vaccines, %			
Strongly agree	4.1	5.4	3.9
Agree	19.2	19.4	21.8
Neither agree nor disagree	48.4	48.2	42.7
Disagree	19.2	19.7	22.0
Strongly disagree	9.1	7.3	9.6
I will take a COVID-19 vaccine if many others have taken it, %			
Strongly agree	1.3	0.8	1.6
Agree	12.7	10.6	13.7
Neither agree nor disagree	30.8	33.4	23.6
Disagree	24.9	24.9	28.8
Strongly disagree	30.3	30.3	32.4
I will take a COVID-19 vaccine if a COVID-19 vaccine certificate or passport were required for work or school, %			
Strongly agree	6.7	6.7	5.4
Agree	29.0	26.2	30.8
Neither agree nor disagree	29.5	33.9	28.8
Disagree	14.8	12.7	13.5
Strongly disagree	19.9	20.5	21.5
I will take a COVID-19 vaccine if a COVID-19 vaccine certificate or passport were required for travel, social events or dine-in, %			

Strongly agree	6.0	4.7	6.2
Agree	23.3	22.3	25.6
Neither agree nor disagree	30.1	33.2	25.1
Disagree	17.4	16.8	18.4
Strongly disagree	23.3	23.1	24.6
COVID-19 vaccination should be compulsory for all citizens in Japan, %			
Strongly agree	1.0	0.8	1.3
Agree	2.8	2.1	2.3
Neither agree nor disagree	23.1	19.4	18.4
Disagree	18.7	23.6	19.9
Strongly disagree	54.4	54.1	58.0
In the past month, on average, how much time per day have you spent actively using social media? (%)			
None	9.3	9.3	9.1
Less than 10 min	19.4	23.1	22.0
More than 10 min–less than 30 min	20.5	26.2	23.3
More than 30 min–less than 60 min	18.9	14.5	18.7
More than 1 hour–less than 2 hours	16.3	13.2	11.7
More than 2 hours–less than 3 hours	6.2	5.4	3.4
More than 3 hours per day	9.3	8.3	11.9
In the past month, what social media platforms have you usually used? (%)			
Facebook	34.5	35.8	36.8
Twitter	54.4	57.5	57.8
YouTube	73.3	77.7	75.1
WhatsApp	2.1	0.8	0.8
LINE	81.9	86.5	83.9
Facebook Messenger	10.9	11.7	12.7
Instagram	47.2	43.8	43.5
TikTok	9.3	10.4	7.5

LinkedIn	1.8	1.6	1.3
Don't use social media	2.6	2.8	3.6
In the past month, from which of these social media platforms have you received information regarding COVID-19 vaccine from? (%)			
Facebook	8.0	7.5	10.1
Twitter	23.2	19.2	25.1
YouTube	22.0	21.2	23.3
WhatsApp	0.0	0.3	0.0
LINE	15.8	13.0	16.1
Facebook Messenger	0.8	0.5	2.1
Instagram	7.5	6.7	7.3
TikTok	1.8	1.6	2.6
LinkedIn	0.5	0.3	0.0
Not received information from social media	57.0	59.6	52.6
Have you ever seen or heard any COVID-19 associated information on social media that might have persuaded you not to immunize yourself/your child/children against COVID-19? (%)			
Yes	34.2	37.8	40.4
No	44.6	39.9	38.3
Don't know	21.2	22.3	21.2
Genetic recombination technology is used in COVID-19 vaccine to cause changes in genes (chromosomes) through vaccination, %			
True	16.3	19.4	12.4
Unsure	59.8	56.2	64.0
False	23.8	24.4	23.6

Many people have died after getting the COVID-19 vaccines, %			
True	46.1	43.5	42.5
Unsure	37.3	38.1	40.2
False	16.6	18.4	17.4
COVID-19 vaccination is associated with infertility and/or miscarriage, %			
True	14.2	17.4	11.9
Unsure	62.7	60.4	63.7
False	23.1	22.3	24.4
COVID-19 vaccination causes COVID-19 infection to those who receive the vaccines and people around them, %			
True	11.1	12.7	13.5
Unsure	44.3	41.2	41.7
False	44.6	46.1	44.8
COVID-19 vaccines were approved without completing the normal process of the clinical trial, %			
True	40.2	46.1	42.7
Unsure	41.7	36.3	35.8
False	18.1	17.6	21.5
The safety of COVID-19 vaccines has not been confirmed yet because the clinical trial is not completed yet, %			
True	49.7	52.6	48.2
Unsure	38.3	32.9	37.0
False	11.9	14.5	14.8
In animal experiments, many animals died after getting the COVID-19 vaccines, %			
True	19.4	16.3	18.9
Unsure	61.4	67.9	58.5
False	19.2	15.8	22.5

Perception of COVID-19 vaccine			
Do you want to receive a COVID-19 vaccine in the future? (%)			
Yes, definitely (Screened out)	0	0	0
Unsure, but leaning towards yes	21.8	18.9	20.7
Unsure, but leaning towards no	34.2	33.9	34.7
No, definitely not.	44.0	47.2	44.6
COVID-19 vaccines are important, %			
Strongly agree	7.3	6.0	6.7
Tend to agree	29.8	27.7	29.0
Do not know	31.3	36.0	32.6
Tend to disagree	15.0	16.4	16.3
Strongly disagree	16.6	14.2	15.3
COVID-19 vaccines are safe, %			
Strongly agree	0.5	1.6	0.8
Tend to agree	8.5	8.5	9.3
Do not know	38.3	38.9	37.3
Tend to disagree	25.9	28.0	28.5
Strongly disagree	26.7	23.1	24.1
COVID-19 vaccines are effective, %			
Strongly agree	3.9	4.7	3.9
Tend to agree	36.5	36.5	35.5
Do not know	33.7	34.5	32.1
Tend to disagree	10.6	12.2	16.3
Strongly disagree	15.3	12.2	12.2

^a Chi-square or Fisher's exact test

^b According to the response "No underlying health conditions" only. Some participants reported both "Chronic respiratory disease / Chronic heart disease" and "No underlying health conditions"

Table S2. Full logistic model results for between-arms comparison of vaccine intention and confidence after interventions under an intention-to-treat analysis. Missing outcomes were imputed using multiple imputation method.

All participants (n=1158)	Group 2 (chatbot) vs. Group 1 (control) OR (95% CI)	Group 3 (webinar) vs. Group 1 (control) OR (95% CI)
Willing to be vaccinated^a		
Constant	0.2 (0.2, 0.3)	0.2 (0.2, 0.3)
Group difference	0.8 (0.5, 1.3)	1.1 (0.7, 1.6)
Improvement in vaccine confidence^b		
COVID-19 vaccines are important		
Constant	0.2 (0.1, 0.2)	0.2 (0.1, 0.2)
Baseline confidence in vaccine importance	13.2 (8.9, 19.6)	13.8 (9.2, 20.5)
Group difference	1.3 (0.9, 2.0)	1.8 (1.2, 2.8)
COVID-19 vaccines are safe		
Constant	0.1 (0.1, 0.1)	0.1 (0.1, 0.1)
Baseline confidence in vaccine safety	14.1 (7.8, 25.4)	11.0 (6.1, 19.7)
Group difference	1.1 (0.7, 1.9)	1.6 (1.0, 2.6)
COVID-19 vaccines are effective		
Constant	0.1 (0.1, 0.2)	0.1 (0.1, 0.2)
Baseline confidence in vaccine effectiveness	11.8 (8.0, 17.4)	11.0 (7.5, 16.2)
Group difference	1.4 (0.9, 2.1)	2.2 (1.4, 3.4)

^a Including those who have received a COVID-19 vaccine or not received a COVID-19 vaccine but are willing

^b Difference in % (post-intervention vs. pre-intervention) of those who responded “strongly agree” or “tend to agree.” (Other responses were “do not know,” “tend to disagree,” “strongly disagree”)

Table S3. Association between chatbot access and vaccine intention and confidence.

	No. of chatbot accesses, median (IQR)		p-value ^a
	Yes	No	
Group 2 (chatbot) (n=231)			
Willing to be vaccinated ^b	15 (9-29)	9 (6-13)	<0.001
Vaccine confidence index after chatbot use			
COVID-19 vaccines are important	10 (7-15)	10 (7-15)	0.158
COVID-19 vaccines are safe	12 (10-14)	9 (6-15)	0.510
COVID-19 vaccines are effective	10 (7-17)	9 (6-14)	0.208
Perceptions of COVID-19 or vaccination after chatbot use			
Willing to vaccinate their child/children against COVID-19	12 (9-16)	10 (7-14)	0.046
I may get COVID-19 infection within the next 6 months	11 (7-15)	10 (6-15)	0.151
COVID-19 is a serious disease	11 (7-16)	9 (6-13)	0.632
I believe that getting a COVID-19 vaccine will ease my anxiety	13 (10-18)	9 (6-14)	0.837
I do not need to take a COVID-19 vaccine because I wash hands frequently with soap or sanitizer, which can help prevent the spread of COVID-19	9 (7-13)	10 (6-15)	0.538
I do not need to take a COVID-19 vaccine because I practice social distancing, which can help prevent the spread of COVID-19	9 (7-13)	10 (6-15)	0.749
I believe a vaccine can help control the spread of COVID-19	11 (7-16)	9 (6-15)	0.573
It is easy to find relevant information on COVID-19 vaccines	12 (7-18)	9 (6-14)	0.397

I will take a COVID-19 vaccine if many others have taken it.	12 (9-15)	10 (6-15)	0.050
I will take a COVID-19 vaccine if a COVID-19 vaccine certificate or passport were required for work or school.	12 (8-16)	9 (5-14)	0.456
I will take a COVID-19 vaccine if a COVID-19 vaccine certificate or passport were required for travel, social events or dine-in	10 (7-15)	10 (6-15)	0.088
COVID-19 vaccination should be compulsory for all citizens in Japan	10 (9-12)	10 (6-15)	0.476

^a Difference in willingness to be vaccinated was assessed by logistic regression model; changes in VCI and perception of COVID-19 or vaccination were assessed by mixed effects logistic regression model. Both models used logarithm of the number of chatbot access due to the skewness of the access distribution.

^b Including those who have received a COVID-19 vaccine or not received a COVID-19 vaccine but are willing.

Table S4. Association between webinar attendance and vaccine intention and confidence.

	Duration of webinar attendance (minutes), median (IQR)		p-value ^a	No. who attended webinar sessions, median (IQR)		p-value ^a
	Yes	No		Yes	No	
Group 3 (webinar) (n=207)						
Willing to be vaccinated ^b	52 (41-65)	61 (44-70)	0.211	1 (1-1)	1 (1-1)	0.373
Vaccine confidence index after webinar use						
COVID-19 vaccines are important	60 (44-67)	58 (43-70)	0.798	1 (1-1)	1 (1-1)	0.959
COVID-19 vaccines are safe	61 (43-71)	59 (44-70)	0.096	1 (1-1)	1 (1-1)	0.154
COVID-19 vaccines are effective	60 (45-67)	58 (42-70)	0.378	1 (1-1)	1 (1-1)	0.457

^a Difference in willingness to be vaccinated was assessed by logistic regression model; changes in vaccine confidence index and perception to COVID-19 or vaccination were assessed by mixed effects logistic regression model. Both models used logarithm of the number of webinar attendance access due to the skewness of the access distribution.

^b Including those who have received COVID-19 vaccine or not taken COVID-19 vaccine but willing to received.

Table S5: Vaccine intention among participants with and without improvement in vaccine confidence after intervention under an intention-to-treat analysis. Missing outcomes were imputed using multiple imputation method.

All participants (n=1158)	Willing to be vaccinated ^a		
	Group 1 (control) n=386 (%)	Group 2 (chatbot) n=386 (%)	Group3 (webinar) n=386 (%)
Improvement in vaccine confidence ^b			
COVID-19 vaccines are important			
Improved	9.6	14.9	25.2
Did not improve	19.4	15.5	18.7
COVID-19 vaccines are safe			
Improved	50.8	37.8	36.4
Did not improve	16.3	13.7	17.8
COVID-19 vaccines are effective			
Improved	27.8	23.7	25.9
Did not improve	17.8	14.5	18.6

^a Including those who have received a COVID-19 vaccine or not received a COVID-19 vaccine but are willing

^b Improvement in vaccine confidence refers to those who responded “do not know,” “tend to disagree,” “strongly disagree” pre-intervention and responded “strongly agree” or “tend to agree.” post-intervention.

Table S6. Vaccine intention and confidence after interventions under a per-protocol analysis.

All participants (n=797)	Group 1 (control) n=359 (%, 95% CI)	Group 2 (chatbot) n=231 (%, 95% CI)	Group3 (webinar) n=207 (%, 95% CI)	Group 2 vs. Group 1		Group 3 vs. Group 1	
				OR (95% CI)	p-value ^a	OR (95% CI)	p-value ^a
Willing to be vaccinated ^b	18.7 (14.6, 22.7)	14.7 (10.1, 19.3)	18.8 (13.5, 24.2)	0.8 (0.5, 1.2)	0.215	1.0 (0.7, 1.6)	0.958
Change in vaccine confidence ^c							
COVID-19 vaccines are important	-2.2 (-9.2, 4.8)	-0.8 (-9.7, 7.9)	8.7 (-0.7, 18.1)	1.1 (0.7, 1.7)	0.659	2.0 (1.3, 3.1)	0.002
COVID-19 vaccines are safe	1.9 (-2.5, 6.4)	1.7 (-4.1, 7.6)	4.8 (-1.4, 11.1)	1.1 (0.6, 1.9)	0.797	1.4 (0.8, 2.4)	0.241
COVID-19 vaccines are effective	-8.1 (-15.1, -1.0)	-3.5 (-12.5, 5.5)	5.3 (-4.3, 14.9)	1.4 (0.9, 2.2)	0.086	2.3 (1.5, 3.5)	<0.001

^a Assessed by logistic regression model.

^b Including those who have received a COVID-19 vaccine or not received a COVID-19 vaccine but are willing.

^c Difference in % (post-intervention vs. pre-intervention) of those who responded "strongly agree" or "tend to agree." (Other responses were "do not know," "tend to disagree," "strongly disagree")

Table S7. Baseline participant characteristics and perceptions of COVID-19 vaccines by chatbot and webinar groups and completion of intervention.

	Group 2 (chatbot) n=386		Group 3 (webinar) n=386	
Participants in the chatbot and webinar groups n=772	Intervention completed, n=231	Non-compliant, n=155	Intervention completed, n=207	Non-compliant, n=179
Characteristics				
Age (y), mean	45.0	46.9	44.6	48.0
Gender, % male	51.5	60.0	50.1	61.5
Education, %				
High school or less	24.7	29.7	32.9	33.0
Professional or vocational qualification	22.5	21.9	14.5	18.2
Bachelor's degree or above	52.8	48.4	52.7	48.6
Employment, %				
Full-time	48.9	58.1	53.1	53.1
Part-time	16.0	16.8	18.0	20.7
Unemployed	20.8	14.8	17.9	15.6
Retired	3.9	3.2	2.4	3.9
Students	0.9	1.3	0.5	0.6
Others	9.5	5.8	7.2	6.1
Healthcare worker, %	2.6	3.9	1.9	4.5
Marital status, %				
Married	48.9	44.5	50.2	46.9
Never married	43.3	36.8	38.6	40.2
Divorced	6.5	18.7	10.6	10.1
Widowed	0.9	0.0	0.5	2.8
Others	0.4	0.0	0.0	0.0
Income, %				
< JPY 200 mil	35.1	41.3	40.1	32.4
JPY 200-399 mil	28.6	23.2	19.3	33.0
JPY 400-599 mil	19.9	19.4	23.2	23.5

JPY 600-799 mil	6.9	5.2	11.1	6.1
≥ JPY 800 mil	9.5	11.0	6.3	5.0
Underlying health conditions, %	2.6	3.9	1.9	4.5
Usually received flu vaccine, %	13.4	9.0	16.9	17.3
Diagnosed with COVID-19, %	3.0	1.3	1.9	0.6
Ever experienced a side effect or allergy after any vaccination, %				
Yes	10.0	4.5	11.6	8.4
No	85.3	85.2	80.7	84.9
Unsure	4.8	10.3	7.7	6.7
Perception of COVID-19 vaccine				
Do you want to receive a COVID-19 vaccine in the future? (%)				
Yes, definitely (Screened out)	0	0	0	0
Unsure, but leaning towards yes	18.2	20.0	20.8	20.7
Unsure, but leaning towards no	36.4	30.3	33.3	36.3
No, definitely not.	45.5	49.7	45.9	43.0
COVID-19 vaccines are important, %				
Strongly agree	8.2	2.6	5.3	8.4
Tend to agree	29.0	25.8	31.4	26.3
Do not know	35.1	37.4	32.9	32.4
Tend to disagree	13.4	20.0	15.0	17.9
Strongly disagree	14.3	14.2	15.5	15.1
COVID-19 vaccines are safe, %				
Strongly agree	0.9	2.6	0.5	1.1
Tend to agree	10.0	6.5	9.2	9.5
Do not know	39.4	38.1	36.2	38.5
Tend to disagree	26.8	29.7	30.9	25.7
Strongly disagree	22.9	23.2	23.2	25.1
COVID-19 vaccines are effective, %				
Strongly agree	5.6	3.2	2.4	5.6
Tend to agree	38.1	34.2	40.1	30.2
Do not know	33.8	35.5	30.4	34.1

Tend to disagree	10.0	15.5	15.0	17.9
Strongly disagree	12.6	11.6	12.1	12.3