



Public Attitudes toward COVID-19 Vaccinations before Dawn in Japan: Ethics and Future Perspectives

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Abstract

Improving public understanding and acceptance are critical for promoting coronavirus (COVID-19) vaccination. However, how to promote COVID-19 vaccine programs remains controversial due to various ethical issues. This study, thus, aimed to survey the acceptance of COVID-19 vaccines among Japanese citizens and discuss relevant ethical issues. A cross-sectional survey was conducted via an online platform. An anonymous, quantitative, self-administered online questionnaire was sent to 6965 registered Japanese residents (20–79 years of age), which included questions regarding the respondent's general knowledge, experience, and opinions of vaccines, vaccine development, COVID-19, and COVID-19 vaccines. Of the 1569 respondents, 730 (46.5%) and 839 (53.5%) were categorized into the younger and older groups, respectively. Most of the respondents possessed general knowledge of COVID-19 vaccines and their features. Of the respondents, 57.8% definitely agreed (10.5%) or somewhat agreed (47.3%) to receive COVID-19 vaccines. The older group showed significantly greater willingness to receive vaccines and higher literacy regarding vaccines in general. Possible reasons for the older group's greater willingness to receive COVID-19 vaccines are a high risk of severe COVID-19 infection and their past accumulated experience of receiving various vaccinations. Although active public intervention could increase vaccination rates, most of the respondents did not agree with mandatory vaccination. Furthermore, a gap between the participants in the COVID-19 vaccine trials and the prioritized population in real-world vaccination should be adjusted in future vaccine development.

Keywords COVID-19 · SARS-CoV-2 · Vaccine acceptance · Vaccine

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Background

Efforts toward global vaccination against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) have been increased due to the urgency in fighting the coronavirus 2019 (COVID-19) pandemic. Following the UK, where the first COVID-19 vaccinations were administered on December 8, 2020, many countries have introduced COVID-19 vaccines. More than 2.66 billion doses have been administered and 10% of the global population have been fully vaccinated as of 22 June 2021 (Mathieu et al. 2021). Vaccination programs in Asian countries have been delayed compared with those in the USA and other European countries; Japan began administering vaccinations on 17 February 2021, making it the last among the G7 countries. Most countries, including Japan, prioritize specific groups for receiving the vaccination, with medical staff and elderly people being considered higher priorities than other groups.

Encouraging public understanding and acceptance of vaccines is crucial for promoting vaccination. Previous studies have demonstrated changing global trends in COVID-19 vaccine acceptance; thus, acceptance rates decreased from July 2020 to December 2020, and widespread demand for vaccinations was reported at the beginning of 2021 (Boyon 2020). Another study reported that the number of people who intended to become vaccinated decreased as the pandemic progressed during 2020 (Robinson et al. 2021). Although the overall trend of COVID-19 vaccine acceptance has been on the rise, there remains a certain vaccine hesitancy. Populations in nations such as Japan, where there was strong vaccine hesitancy prior to the COVID-19 pandemic, have shown the lowest level of vaccination intent.

In Asian countries, there have been various studies conducted to understand the public's COVID-19 vaccine acceptance/hesitancy (Marzo et al. 2022). In East and Southeast Asia, the overall acceptance rates among the general public were relatively high compared to some countries in the Middle East, Russia, Africa, and several European countries (Sallam 2021). Vaccine hesitancy among middle-aged and older adults has been a significant obstacle in Singapore's battle against COVID-19, and people's trust in official information sources has influenced their vaccination status (Tan et al. 2022). In South Korea, 79% of the respondents agreed to be vaccinated, and a lack of trust in the government's COVID-19-related countermeasures was associated with vaccine hesitancy (Park et al. 2021). A study conducted in Malaysia in December 2021 showed that 64.5% of the respondents were willing to get vaccinated regardless of whether they had appropriate knowledge of COVID-19 vaccines (Mohamed et al. 2021). Taiwan showed relatively lower (52.7%) vaccine acceptance than other high-income countries, which was negatively associated with people's risk perception of COVID-19 (Tsai et al. 2021). In addition to the public attitude toward COVID-19 vaccination, various ethical issues surround vaccination, including incentives for vaccination (Persad and Emanuel 2021), vaccine development (Wibawa 2021), and vaccine distribution (Jecker et al. 2021).

Since the first COVID-19 vaccination was administered, 7.3% of Japanese citizens have received their shots as of 22 June 2021 (Mathieu et al. 2021). Individuals

in Japan have had time to consider their vaccination plans while observing data on vaccines reported for other countries, including adverse effects of the vaccines or suspensions of vaccine clinical trials. A previous study in Japan reported that a higher proportion of people aged ≥ 65 years showed a willingness to be vaccinated compared with those of other age groups; however, the reasons for these differences remain unclear (Machida et al. 2021). Furthermore, the optimal ways in which to promote COVID-19 vaccine programs remain controversial.

Objective

This study aimed to determine the rates and reasons for acceptance of COVID-19 vaccines among Japanese citizens during a time when vaccinations have been administered widely in the UK and USA, where the vaccination rates are far higher than those of many other countries worldwide. We focused on differences in attitudes toward COVID-19 vaccination among various age groups. Furthermore, we addressed a number of the ethical issues related to the COVID-19 vaccine policy and development strategy, including vaccination priority, clinical trial strategies, and vaccine promotion.

Materials and Methods

Survey Design and Participants

The study design used a cross-sectional survey conducted via an online platform provided by INTAGE Inc., Japan. We sent an anonymous, quantitative, and self-administered online questionnaire to 6965 registered Japanese residents (aged 20–79 years) and collected responses from 1569 individuals selected in accordance with the same distribution of age, sex, and residential area for the demographic group as used by the latest census of the Japanese general population. INTAGE Inc. created web pages for recruiting volunteers from the panel of targeted residents, collected responses, and sent us the dataset, including each response, without disclosing any information that could be used to directly identify the participants. The questionnaire was designed to elicit an online reply after each potential respondent had read an explanation of the study's purpose. The data collection period was 22–24 December 2020. Only full answers were counted in the data analysis.

Our online survey using a self-administered anonymous questionnaire did not obtain any personal identifying information about the participants, and it fell outside the scope of the Japanese government's Ethical Guidelines for Medical and Health Research Involving Human Subjects, which made it exempted from the requirement for an ethics review. All participants gave their consent to participate in the survey. After being informed about the study purposes and their right to withdraw from the survey, the participants agreed to answer the questions. They were provided with the option "I don't want to respond" for sensitive questions. Completion of the entire questionnaire was considered to indicate participant consent.

Questionnaire and Analysis

The questionnaire was developed by means of discussion among the authors. We collected the relevant surveys on COVID-19, then extracted and developed the items according to our research objectives. After developing a draft, we conducted a pre-test for six colleagues who were not on the research team to help make the questionnaire clearer and more comprehensive. The questionnaire included five sections: (A) general knowledge of vaccines and vaccine development; (B) knowledge and experience of COVID-19; (C) opinions on COVID-19 vaccines; (D) opinions and experiences of vaccination and the development of a new vaccine against emerging infectious diseases; and (E) individual characteristics (see Supplementary Material). Most items were multiple-choice questions or used a 4- or 5-point scale.

In section A, we included an item to assess the prioritization of public interest based on a 10-point scale. The respondents were asked to select the number of points that applied to them, with 1 representing the idea that the interests of the nation as a whole should be valued more than the interests of individuals and 10 representing the idea that the interests of individuals should be valued more than the interests of the nation. A lower score indicated a high awareness of public interest.

In section D, the respondents were asked “If the COVID-19 vaccine became available in Japan at this moment, would you be willing to receive it?” as the first question to assess their willingness. Next, they were asked to choose all reasons for their willingness. After that, the participants were queried regarding vaccine policies such as mandatory COVID-19 vaccination and exemption of vaccine manufacturers’ financial responsibilities for vaccine-related health injuries. At the end of section D, the participants were again asked “If the COVID-19 vaccine became available, would you be willing to receive it?” as the second question of their willingness, to assess wavering responses. During the survey, we provided information that might be considered a negative aspect of the vaccination, such as past vaccine- or medication-related health disasters in Japan and that SARS-CoV-2 mutates so quickly that a vaccine might be less effective to new variants. The respondents who agreed to be vaccinated were asked “When do you want to be vaccinated?”

We defined the younger group as participants aged 20–49 years and the older group as participants aged 50–79 years, considering the median age and the amendment of the Immunization Act in 1994 in Japan. With this amendment, Japan abolished mandatory vaccination, which could have influenced the respondents’ attitude toward vaccination. Descriptive statistics and the chi-squared test were applied for analysis. The level of knowledge, willingness to be vaccinated, and opinions on COVID-19 vaccine-related policies were compared between the age groups. Two-sided p -values ≤ 0.05 were considered statistically significant. All analyses were performed using the SPSS (ver. 25.0) statistical software.

Results

Respondents' Characteristics

Of the 1569 respondents, 730 (46.5%) and 839 (53.5%) were categorized into the younger and older groups, respectively (Table 1). Most respondents possessed general knowledge of vaccines and features of COVID-19. The older group showed a significantly higher rate of seasonal influenza vaccine uptake in the past year than the younger group (43.4% vs. 37.0%, $p < 0.05$), excluding 24 respondents who answered, "I do not remember." The older group was more concerned with the public interest than the younger group (4.67 vs. 4.92, $p < 0.05$).

COVID-19 Vaccine Attitudes and Reasoning

There was no significant change in the willingness to receive the COVID-19 vaccination between the first and second questions, which assessed willingness. We therefore focused on the results of the first question.

Of the respondents, 57.8% chose *definitely agree* (10.5%) or *somewhat agree* (47.3%) to receive COVID-19 vaccines, whereas 42.2% answered *definitely disagree* (6.4%) or *somewhat disagree* (35.8%). The main reasons for receiving vaccinations were "I want to protect myself and my family from COVID-19" (81.4%); "I think I can prevent becoming infected with COVID-19" (63.5%); "I think I can prevent the onset of COVID-19" (63.5%); and "I think I can avoid severe cases of COVID-19" (62.8%). The major reasons against COVID-19 vaccination were "I am worried about adverse reactions to the vaccine" (77.9%) and "I don't think there is enough information on the safety and effectiveness of vaccines" (58.9%).

The percentage of participants who agreed to be vaccinated against COVID-19 was significantly higher in the older group ($p < 0.001$) (Fig. 1) and increased as the respondents' age increased: 48.9% were in their 20s; 52.8% were in their 30s; 59.7% were in their 60s; and 70.2% were in their 70s. The reasons for the willingness to vaccinate in each age group are shown in Fig. 2. The reasons for being willing to be vaccinated were more diverse than those for being unwilling to do so. The more specific reasons in the older group were "I think I can avoid severe cases of COVID-19," "I think I can prevent the onset of COVID-19," "The vaccine is not effective unless many people are vaccinated," and "I have an underlying disease such as asthma or diabetes."

Attitudes toward the Social Implementation of the COVID-19 Vaccine and General Knowledge of the Vaccine

The older group was significantly more familiar than the younger group with how vaccines work, their adverse events, herd immunity, and the expected benefits of vaccines (Table 2). There was no statistically significant difference between the two groups regarding their attitudes toward COVID-19 vaccination policies. The respondents thought that a vaccination certificate should be requested when entering/

Table 1 Characteristics of the respondents

<i>N</i> = 1,569		%	<i>n</i>	
Sex	Female	50.6	794	
	Male	49.4	775	
Age (average: 51.2, median: 51)	20s	12.4	194	
	30s	14.3	225	
	40s	19.8	311	
	50s	18	283	
	60s	17.7	278	
	70s	17.7	278	
Employment status	Full time	33.3	522	
	Part time	16.6	260	
	Self-employed	6.7	105	
	Unemployed	43.5	682	
Education	Junior high school	2.4	37	
	Senior high school	31.4	493	
	College	22.7	356	
	University	38.1	598	
	Graduate school	4.3	67	
	Unknown	1.1	18	
Household income	< \$40,000	43.7	686	
	\$40,000–\$60,000	25.4	399	
	\$60,000–\$80,000	13.8	217	
	\$80,000–\$100,000	7.7	121	
	> \$100,000	9.3	146	
Health condition	I have visited a hospital in the past year.	20s	33.5	65
		30s	44.9	101
		40s	47.3	147
		50s	59.4	168
		60s	70.1	195
		70s	80.6	224

Table 1 (continued)

		%	n	
<i>N</i> = 1,569				
Knowledge about vaccines	I have never heard of “vaccines.”	99.6	1,562	
	Did you know that vaccines use the immune system?	Yes 92.9	1,451	
	Did you know that all vaccines have adverse reactions?	Yes 94.4	1,475	
	Did you know that the collective immunity effect of vaccination can prevent the spread of infectious diseases?	Yes 91.1	1,423	
	Did you know that there are three types of effects expected from vaccines: protection against infection, prevention of disease onset, and prevention of severe disease?	Yes 87.5	1,366	
	How long do you think it takes to develop a vaccine in general?	Less than a year	4.4	68
		1–5 years	49	765
5–10 years		32.7	510	
≥ 10 years		14	219	
Knowledge and experience of clinical trials	I have never heard of “clinical trial.”	95.9	1,505	
	I have never participated in a clinical trial.	7.1	107	
Knowledge and experience of COVID-19	Did you know that people with underlying medical conditions and the elderly become severely ill more quickly with COVID-19?	Yes 94.8	1,488	
	Did you know that there are asymptomatic cases of COVID-19?	Yes 96.9	1,521	
	I have never heard of “vaccine for COVID-19.”	90.6	1,442	
	I or people around me have had COVID-19.	5.9	93	

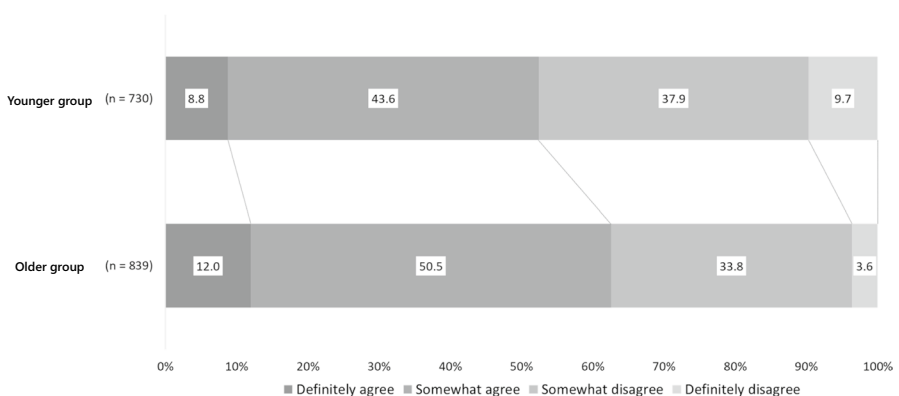


Fig. 1. Willingness to receive COVID-19 vaccine if it becomes available today

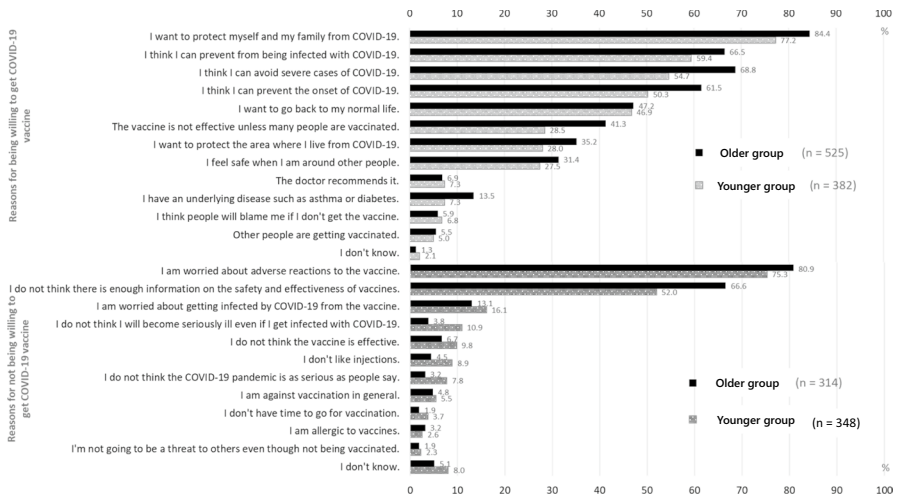


Fig. 2. The reasons for willingness/unwillingness to receive the COVID-19 vaccine

leaving Japan (68.0%), visiting medical facilities and nursing homes (44.4%), participating in large-scale events such as concerts and sports events (40.1%), and staying in accommodation facilities including hotels during a domestic trip (39.4%). Among those who disagreed with mandatory COVID-19 vaccination laws (83.2%), 43.8% believed that all people should be vaccinated even in the absence of a legal mandate, whereas 39.4% believed that it is up to the individual whether to get COVID-19 vaccines in the absence of a legal mandate. A total of 60.6% of the respondents excluding the do-not-know responses supported vaccination of the entire population, regardless of whether it is mandated by law.

Discussion

Our survey revealed the attitudes of a Japanese population toward COVID-19 vaccination as of December 2020, in which nearly 60% of the respondents were willing to become vaccinated. Safety concerns regarding the vaccines were most common among respondents unwilling to get vaccinated. These results support findings in previous studies conducted after our survey, in which 62.1% of the participants in January 2021 (Machida et al. 2021) and 74% of the participants in February 2021 agreed to receive COVID-19 vaccines in Japan (Lacey 2021). Therefore, there appears to be an increasing trend in the demand for vaccines among individuals that began prior to the start of the vaccination programs in Japan, and it has continued to increase. Nonetheless, many of our respondents were still undecided, given that only 10.5% said they “definitely agree” to receive COVID-19 vaccines. Among the national affiliations of participants responding to a global survey administered in

Table 2. Attitudes toward social implementation of the COVID-19 vaccine and general knowledge of the vaccine

	Total	Younger group		Older group		<i>p</i>
		<i>n</i>	%	<i>n</i>	%	
<i>Do you think that ...</i>						
You have received enough explanations and information about the COVID-19 vaccines from various sources. (<i>n</i> = 967)*	Yes No	384 583	39.7 60.3	157 304	34.1 65.9	44.9 55.1
A certificate of vaccination should be requested in particular situations. (<i>n</i> = 1,569)	Yes No	1,322 247	84.3 15.7	604 126	82.7 17.3	85.6 14.4
The order of priority vaccination is reasonable. (<i>n</i> = 1,509)*	Yes No	1,311 198	86.9 13.1	577 144	83.5 16.5	89.7 10.3
COVID-19 vaccination should be required by law. (<i>n</i> = 1,427)*	Yes No	240 1,187	16.8 83.2	110 537	17.0 83.0	16.7 83.3
It is necessary to reduce the financial responsibility of companies in the case of adverse reactions caused by COVID-19 vaccine. (<i>n</i> = 1,380)*	Yes No	844 536	61.2 38.8	395 239	62.3 37.7	60.2 39.8
<i>Did you know that ... (n = 1,562)#</i>						
Vaccines are based on immunity, which is the ability of the body to attack pathogens that enter the body from outside.	Yes No	1,451 111	92.9 7.1	654 71	90.2 9.8	95.2 4.8
Adverse reactions can occur with all vaccines, including influenza vaccines.	Yes No	1,475 87	94.4 5.6	666 59	91.9 8.1	96.7 3.3
If a large number of people are vaccinated to gain immunity against infectious diseases, it can prevent the spread of infectious diseases even when there are infected people in the population.	Yes No	1,423 139	91.1 8.9	625 100	86.2 13.8	95.3 4.7
There are three types of effects expected from vaccines: protection against infection, prevention of disease onset, and prevention of serious illness.	Yes No	1,366 196	87.5 12.5	609 116	84.0 16.0	90.4 9.6

*Excluding "I don't know." #Excluding "I have never heard the word 'vaccine'."

December 2020, Japan showed the lowest proportion of those who “strongly agreed” to receive the COVID-19 vaccine (11%) (Boyon 2020).

The Japanese might consider the available data carefully before making a final decision. The second most common reason given by our respondents unwilling to get vaccinated was “lack of information on safety and efficacy.” More than 80% of the respondents willing to get vaccinated did not want to receive it immediately, because they were waiting for clearer data on the vaccines’ adverse effects and efficacy. Safety concerns are a critical consideration for individuals in the decision-making stage of COVID-19 vaccination (SteelFisher et al. 2021). Before Japan experienced the human papillomavirus vaccination crisis (Larson 2020) and other medication-related health injuries, several people stated that they were skeptical of vaccines in general (de Figueiredo et al. 2020). In addition, information with no scientific evidence has spread to support the perception that COVID-19 vaccines are unsafe (Horton 2020). More information on the COVID-19 vaccine and how it is administered can influence attitudes. The provision of information on vaccines will need to be transparent and updated frequently to keep pace with accumulating evidence.

Vaccine acceptance will change in each country depending on various factors, including the spread of COVID-19 infection, approval status of vaccines or roll-out, and access to COVID-19 vaccines (Johns Hopkins Center for Communication Programs 2021). In Japan, the COVID-19 vaccine acceptance rate has continued to increase after our survey due to the implementation of vaccination programs, the spread of COVID-19 infection among younger people, and mass media reports of other countries’ high completed vaccination rates. Our data also provided information on the rate of acceptance of COVID-19 vaccines prior to the implementation of vaccination programs in Japan.

According to our survey, the younger group’s willingness to vaccinate was less than the older group’s willingness, which was similar to the findings of previous studies on COVID-19 vaccine acceptance (Machida et al. 2021). Among the possible reasons are the features of COVID-19, in which older individuals and those with underlying medical conditions tend to develop severe cases more frequently than individuals with other demographic characteristics (World Health Organization 2020a). Furthermore, more than 90% of our respondents knew this information, which might have contributed to enhanced vaccine acceptance among the older group; conversely, it could have enhanced the younger group’s perception that the vaccine did not concern them. Our survey showed that the hesitation to receive COVID-19 vaccines among the younger group included “I do not think that I will become seriously ill even if I get infected with COVID-19” ($n = 38$, 10.9% of the respondents in the younger group who were not willing to receive the COVID-19 vaccine). Another potential reason could be people’s past experiences with vaccination. Many respondents in the older group in our survey could have accumulated more experience receiving vaccinations than in the younger group (Shahrabani and Benzion 2012). For instance, our survey showed that a higher proportion of respondents in the older group had a seasonal influenza shot in the past year than those in the younger group. The Immunization Act, which had required Japanese citizens to take specific vaccines, was amended in 1994 after class action suits relating to

several vaccinations were filed against the Japanese government. Accordingly, vaccination policies shifted from mandatory to a best effort obligation for Japanese citizens. Elderly respondents could have experienced mandatory vaccination according to the former Immunization Act. In contrast, younger people might not have enough vaccination experience to have developed a trust in vaccine safety and efficacy. Younger respondents who disagreed being vaccinated were more likely than older people to select the following reasons regarding the need for vaccination: “I do not think that I will become seriously ill even if I become infected with COVID-19” or “I do not think the COVID-19 pandemic is as serious as people say.” The younger respondents in our survey did not appear to prioritize vaccination as an approach to defeating the COVID-19 pandemic. The older group’s more preferable attitudes toward the public interest and the literacy gap of vaccines between the age groups could have led to differences in their attitudes.

The COVID-19 pandemic situation has been changing rapidly. Mutations in the virus strains have led to a significant increase in severe cases among young people who were previously not considered to be at high risk. This change might influence younger people to take greater precautions against COVID-19 as they realize their own risk of becoming severely ill from COVID-19. If these risks become less significantly different between age groups, the current prioritization of COVID-19 vaccination for older people as a higher priority should be reconsidered (Matsui et al. 2021). The ethical principle supporting the prioritization of high risk cases is the “rule of rescue,” which aims to rescue identifiable individuals facing avoidable death or serious harm (McKie and Richardson 2003). Under this principle, a person has a determined obligation of beneficence toward another person when each of the following conditions is satisfied: the other person is at risk of significant loss of or damage to life, health or some other interest; a rescuer’s action is needed to prevent the other person’s loss; a rescuer’s action has a high probability of preventing the other person’s loss; a rescuer’s action would not present significant risks, costs, or burdens to the other person; and the benefit that the other person can be expected to gain outweighs any harms, costs, or burdens that person is likely to incur (Beauchamp and Childress 2001). If all people were at the same risk of severe conditions, the current prioritization of COVID-19 vaccination would not be supported by the “rule of rescue” principle. Adjustment of vaccination priority according to the current COVID-19 pandemic situation might be based on other ethical principles, such as the “fair innings argument,” which states that everyone has an equal chance to experience a certain span of years, called the “fair innings,” which we consider a reasonable lifespan (Persad et al. 2009). Following this principle, people in the fair innings stage should be treated equally, whereas those who are experiencing life beyond the fair innings stage have lower priority. In our survey, most respondents generally supported the current vaccination priority policy. However, a higher proportion of respondents in the younger group than those in the older group responded that they thought their priority was inappropriate. These opinions could change if the age group of the people who become seriously ill changes. Given that the younger group tended to place more importance on personal interests than on public interests, it will be necessary to evaluate public opinions, including those of

younger people, about priorities because the target age groups' potential for severe COVID-19 infection can change.

In terms of future perspectives, we can first reconsider vaccine policies during the global pandemic era. Most countries have left the decision to receive COVID-19 vaccination to the individual. The World Health Organization has said that persuading people on the merits of a COVID-19 vaccine would be far more effective than attempting to make it mandatory (World Health Organization 2020b; WHO Ethics and COVID-19 Working Group 2021). In contrast, certain countries have introduced a mandatory vaccination policy. Italy approved an emergency decree on April 2021 to make the COVID-19 vaccination mandatory for healthcare workers (Paterlini 2021). In the USA, hospital employees resigned or were fired after refusing to receive the COVID-19 vaccine (Allen 2021). Furthermore, the Philippine president threatened to order the arrest of Filipinos who refused to receive the COVID-19 vaccination (Associated Press 2021). Our survey revealed that only 17% of respondents agreed to a mandatory COVID-19 vaccination law, which suggests that it might be hard to gain broad public support. Nevertheless, more than 60% of respondents agreed to the vaccination of the entire population regardless of legal mandate. The requirement for an immunity passport introduces similar challenges regarding controversial mandatory vaccinations (Kofler and Baylis 2020). The idea is that such certificates would be issued to those who have recovered from COVID-19 and have tested positive for antibodies to SARS-CoV-2. Authorities would lift restrictions on those who are presumed to have immunity in their daily life. This approach is not a direct legal mandate for vaccination but indirectly presses it by placing societal disadvantages, including risks of discrimination. The opposition to a mandatory vaccination policy stems from the belief that it violates an individual's right to refuse unwanted treatment. It could be ethically preferable to incentivize COVID-19 vaccine uptake rather than implementing a direct or indirect mandatory vaccination requirement (Savulescu 2021).

There have been immense efforts to promote COVID-19 vaccine development and distribution globally and in specific communities where there is a high rate of vaccine hesitancy (World Health Organization 2021). Considering the scientific evidence and public support for COVID-19 vaccination, interventions to enhance vaccination rates would be acceptable. Besides disseminating appropriate information on COVID-19 vaccination to the public, the nudge approach has been suggested as an alternative to mandatory vaccination (Patel 2021). Nudges are subtle changes in how choices are offered without mandates, which can avoid the ethical challenges related to mandatory vaccination (Dubov and Phung 2015). If a large number of individuals are unwilling to vaccinate due to normalcy bias, which is based on the fact that they did not get infected with COVID-19, then a nudge approach is likely to be acceptable. If we need to take the vaccine continuously, we need to present the same nudge several times to promote it. However, repeating nudges can be difficult to sustain because people show decreased responses to the same stimulations, a phenomenon known as "habituation" (Thompson and Spencer 1966). Assuming that the supply of vaccines will stabilize and that continuous vaccination will be recommended, it is necessary to consider ways to promote vaccination, including nudging approaches that can avoid habituation.

Second, there appears to be a gap between participants in COVID-19 vaccine trials and the prioritized population in real-world vaccination. Currently, younger people take on the burden of clinical trials, whereas older people receive the benefits of the clinical trials before younger people. Given that the clinical trials have included a small proportion of participants aged over 70 or 75 years, the safety and efficacy for older people needs to be evaluated more precisely. From safety and ethical perspectives, the population who takes on the burden of vaccine clinical trials and those who receive benefits with high priority should be matched as much as possible. Regarding COVID-19 vaccination, older people would be more confident in taking a vaccine when the data on the safety and efficacy of the vaccines are demonstrated by the clinical trials in which an older population is enrolled. As shown in our survey and previous research (SteelFisher et al. 2021), concerns about adverse reactions to vaccines and lack of information on their safety and efficacy are primary reasons for not being willing to take them. Vaccine clinical trials for specific groups, such as children and pregnant women, have been conducted (Pfizer and BioNTech 2021a, b). Due to Japan lagging behind other countries in vaccine development, a strategy might need to be developed to balance the unfairness of sharing the research burden among participants of vaccine clinical trials and the top-priority population for the vaccination. Given that the older population is a high priority for COVID-19 vaccination efforts, Japanese research teams can evaluate the safety and efficacy of the vaccines in the older population by conducting clinical trials.

Conclusion

This study showed the COVID-19 vaccine acceptance rates and trends in Japan just before its administration. The older respondents had significantly greater willingness to take COVID-19 vaccines; one of the potential reasons is their previous experiences with vaccination. In terms of future perspectives, we can promote vaccination with certain incentives and nudging approaches during global pandemics, and more safety and efficacy data need to be shown for the population at higher priority for the vaccination by targeting them as clinical trial participants.

Limitations

There are some limitations to our study. First, the definition of the older group in this survey differs from the standard ≥ 65 years classification, which is commonly used in Japan. Second, our survey indicates the willingness to receive COVID-19 vaccines in a situation where little is known about the gap between the target age group for clinical trials and the priority age group for vaccination. Third, our survey demonstrated vaccine acceptance in Japan in the context of widespread knowledge that COVID-19 tends to be more severe in the older population and that some people are asymptomatic. Vaccine acceptance can differ depending on the disease's characteristics, which might change significantly as strains continue to mutate. Fourth, public perceptions may change over time due to dynamic factors such as an infection rates

increase in Japan, and our quantitative survey could not fully elucidate qualitative aspects of vaccine hesitancy. Nonetheless, the data can be referred to as a baseline of COVID-19 vaccine acceptance in Japan. It also illustrated that safety and efficacy information of vaccines should be adequately updated and shared with the public because people's vaccine hesitancy was related to the lack of them. The development of more safe and effective vaccines may be another key to increasing vaccination rate.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s41649-022-00207-4>.

Data Availability The data of this study are available from the corresponding author upon reasonable request. All data are in Japanese.

Code Availability Not applicable.

Author Contribution All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by HN. The first draft of the manuscript was written by HN and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Declarations

Ethics Approval Our online survey using a self-administered anonymous questionnaire did not obtain any personal identifying information about the participants and fell outside the scope of the Japanese government's Ethical Guidelines for Medical and Health Research Involving Human Subjects, thus exempting the requirement for an ethics review. All participants gave their consent to participate in the survey. After being informed about the purposes of the study and their right to quit the survey, participants agreed to answer the questions. They were provided with the option "I don't want to respond" for sensitive questions. Completion of the entire questionnaire was considered to indicate participant consent.

Competing Interests Haruka Nakada received a research grant from the Japan Agency for Medical Research and Development. Other authors have no relevant financial or non-financial interests to disclose.

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