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COVID-19 Risk Perceptions in Japan: A Cross Sectional Study*

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Abstract

We conducted a large-scale online survey in February 2023 to investigate the perceptions of infection and fatality risks from COVID-19 in Japan. Univariate analysis comparing perceived and actual risk suggests prevalence of overestimation as well as non-negligible underestimation of COVID-19 risks in Japan. Multivariate logistic regression analysis reveals that age, income and educational levels, health status, information sources, and experiences related to COVID-19 are associated with the subjective assessments of infection and fatality risks. Given that risk perceptions are closely correlated with daily socio-economic activities and well-being, it is important for policymakers and public health experts to understand how to communicate COVID-19 risks to the public effectively.

JEL Codes: I10; I12; I18

Keywords: COVID-19, Infection Risk, Fatality Risk, Risk Communication, Risk Perception

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1. Introduction

Risk perceptions—people's subjective judgments about a particular threat—play a central role in how people behave (see, for example, Brewer et al. (2007) and Ferrer and Klein (2015)). In the context of a pandemic, the public's perceptions of associated risks may impact their willingness to engage in preventive behaviors (Bruine de Bruin and Bennett (2020), Sato et al. (2022)), likely affecting the effectiveness of infection control measures by governments, such as social distancing, sanitization, and mask-wearing requirements. Therefore, understanding risk perceptions is crucial in a pandemic.

In this study, we conduct a large-scale nationally representative survey with 40,000 respondents in February 2023 to explore how Japanese people perceive the risks of infection and fatality of COVID-19. We start by eliciting people's assessment of (i) the probability of being infected with COVID-19 within the next month, and (ii) the subjective probability of fatality if infected within the next month. We then collect information on individual background (age, gender, education level, income, etc.), household structure, health situation, and COVID-19-related experiences. We also inquire respondents about their primary type of media (e.g., television, newspaper, internet, SNS, or others) in obtaining information about COVID-19. Our analysis proceeds in two steps. In the first step, we compare perceived risks with actual ones and evaluate the extent of overestimation or underestimation. In the second step, we uncover the factors associated with the overestimation or underestimation of COVID-19 risks through multivariate logistic regression analysis.

Our results are threefold. First, we find that Japanese people overall tended to overestimate infection and fatality risks, though a non-negligible population underestimated these risks. Specifically, at the end of February 2023, 50.2% of respondents perceived the risk of infection as 5% or higher, while the actual infection rate was 0.20%. 29.8% of respondents reported a case fatality rate (CFR) of 5% or higher, in contrast to the actual CFR of 0.24% during the eighth wave of COVID-19 (November 2022-February 2023). At the same time, 17.7% (27.1%) of respondents perceived the risk of infection (fatality) as less than 0.001%. These findings on risk overestimation and underestimation are robust to alternative methods of extracting subjective risk assessments.

Second, there is heterogeneity in risk perceptions across individual attributes. Regarding the perception of infection risk, our results suggest that individuals aged 60 or older and those without a history of COVID-19 contraction are less likely to perceive a very high probability of infection and more likely to perceive a very low probability. Those without pre-existing chronic diseases are less likely to report a very high infection risk compared to others. Turning to the perception of fatality risk, we show that individuals without pre-existing chronic diseases are less (or more) likely to have a very high (or very low) subjective assessment of fatality risk. Less educated and low-income individuals are more likely to perceive fatality risk as very high compared to others, while those who have contracted COVID-19 are less likely to do so. Our findings are consistent across different model specifications and alternative ways of eliciting subjective risks.

Third, we show that information sources are associated with risk perceptions. In particular, readers of the Asahi newspaper exhibit a higher (or lower) likelihood of overestimating (or underestimating) both infection and fatality risks than others. Viewers of NHK-TV and TBS-TV are more likely to overestimate fatality risk and less likely to underestimate fatality risk. In addition, viewers of Fuji-TV and Asahi-TV and readers of the Yomiuri papers have a higher probability of overestimating fatality risk.

On the one hand, a high level of risk perception might have been a factor limiting the spread of the disease because it encourages the practice of infection prevention behaviors. On the other hand, it can lead people to restrict their economic activities, potentially hindering socio-economic recovery. Indeed, there is evidence that socio-economic recovery from the pandemic in Japan has been relatively slow. Specifically, the level of real GDP in 2022 compared to the mean of 2017-2019 was 108 in the US, 102 in Germany, and 101 in the UK, but only 99 in Japan (IMF, 2023). Japanese consumer confidence did not return to pre-pandemic levels, with the real consumption index scoring lower in April 2023 (97.9) than in January 2020 (100.5) (BOJ, 2023). Children's school life had not normalized by spring 2023; many school events were still cancelled in 2022-2023 and more than half of schools forced students to eat lunch silently, which may deteriorate children's mental health (Shobako, 2022; Takaku et al., 2023). The number of marriages dropped sharply in 2020 and has not recovered yet, likely reflecting these socio-economic environments. Given our findings of COVID-19 risk overestimation among Japanese people, correcting the public's misperceptions of risk might be an important task for the government in considering economic activities and infection control.

Our paper is related to the following three strands of the literature. First, it aligns with a set of papers exploring how various factors are associated with COVID-19 risk perceptions in Japan (Adachi et al. (2022)) and other countries (Cipolletta et al. (2022), Dryhurst et al. (2020), Dyer et al. (2022), Gollust et al. (2020), Huynh et al. (2020), Vai et al. (2020), Savadori and Lauriola (2022), Wise et al. (2020), among many others). Our results complement their findings that demographic factors (e.g., age, income, and education), personal factors (health status, COVID-19-related experiences), and the source of media and the behaviors in using such sources (e.g., frequency of use and trust in media) are associated with risk perceptions. The key difference between these papers and ours is that while they solely focus on subjective risk assessments, we compare perceived risks with actual ones and evaluate the extent of risk overestimation and underestimation.

Second, our work is closely related to a few papers comparing the perceived and actual risks such as Abel et al. (2021), Akesson et al. (2022), and Graso (2022).[1] Abel et al. (2021) and Akesson et al. (2022) conduct information provision experiments aimed at correcting beliefs about the risks, while Graso (2022) analyzes the relationship between subjective risks and policy views. Similar to our study, these studies document quantitative evidence of the overestimation of COVID-19 risks. Our work differs from theirs because we direct our attention to various factors associated with risk perceptions and because our sample is substantially larger than their sample (40,000 respondents in our survey versus less than 4,000 respondents in their surveys).

Third, our work is related to the literature analyzing the relationship between COVID-19 risk perceptions and the practice of prevention behaviors. Examples are Bundorf et al. (2023), Bruine de Bruin and Bennett (2020), Garfin et al. (2021), Sato et al. (2022), and Savadori and Lauriola (2022). These papers emphasize that individuals are more likely to engage in social distancing and prevention behaviors—such as wearing masks, rubber gloves, and handwashing—when they perceive higher risks. Our analysis differs from these papers in that we investigate factors associated with risk misperceptions (risk overestimation and underestimation).

[1] Abel et al. (2021) show that people in the US systematically overestimated the fatality rate for young people, but underestimated the risk for the elderly. Akesson et al. (2022) document a significant overestimation of the case fatality rate in the US in March 2020. Meanwhile, Graso (2022) finds that many people in Australia and New Zealand overestimate the risks to children and healthy people.

2. Methods

2.1. Setting and respondents

We conducted a nationally representative cross-sectional survey in February 2023 with 40,000 respondents. We recruited survey respondents online through a collaboration with a survey company (Cross Marketing Inc.). We asked men and women aged 20 and older about their assessment of risks associated with COVID-19 as well as various individual attributes. The response period was from February 22 to February 27, 2023, a period when Japan was in the late stage of the eighth wave of COVID-19. For the trend of the number of daily new cases and deaths during this period, see Figure SI1 in SI Appendix. To ensure that the survey is representative of the general population, the respondents' distributions in age, gender, and place of residence was matched to those in the 2020 Population Census in Japan.

2.2. Perception of COVID-19 risk

Our goal is to understand how people perceive the risks of infection and fatality of COVID-19 and whether various individual attributes are associated with risk perceptions. To this end, we asked survey respondents to rate (1) their subjective probability of becoming infected with COVID-19 within the next month and (2) their subjective probability of fatality if infected within the next month. Answers to these questions were on an ordinal scale and consisted of the following nine options: (1) less than 0.001%, (2) 0.001% to less than 0.01%, (3) 0.01% to less than 0.1%, (4) 0.1% to less than 1%, (5) 1% to less than 5%, (6) 5% to less than 10%, (7) 10% to less than 20%, (8) 20% to less than 50%, and (9) 50% or higher. In a follow-up survey we shall describe shortly, we consider alternative presentations of the probability options to check the robustness of the key messages of our paper.

We contrast those subjective probabilities with the actual probabilities of infection and fatality. To compute actual probabilities, we use (i) data on the population of Japan published by the Statistics Bureau of Japan (MIAC, 2023) and (ii) daily data on the newly confirmed cases and death cases published by the Ministry of Health, Labour and Welfare (MHLW, 2023). According to our calculation, the proportion of new infections with COVID-19 from February 24 to March 23, 2023 (corresponding to one-month period from the survey) accounted for 0.20% of the estimated population of Japan as of March 2023. The case fatality rate in the eighth wave of COVID-19--calculated as the cumulative number of deaths divided by the total number of newly infected cases from November 1, 2022 —to February 28, 2023 is 0.24%.

2.3. Supplemental survey

Because we elicit subjective risk assessments through multiple choices, one concern is that some respondents may conjecture that the middle option is more likely to be correct and choose it accordingly. To check whether this potential bias affects our findings, we implemented an additional survey in April 2023 involving 10,010 respondents. The distributions of age and gender again were matched to those of the 2020 Population Census. In this supplementary survey, respondents were divided evenly into five groups; each group was presented with different answer options on questions about the subjective assessments of risks.

We provided group “Choice A” with the same nine options as in the original survey. Meanwhile, we provide seven options for groups B, C, and D. Group “Choice B” received options (1) less than 0.001%, (2) 0.001% – 0.01%, (3) 0.01% – 0.1%, (4) 0.1% – 1%, (5) 1% – 5%, (6) 5% – 10%, and (7) 10% or higher. Group "Choice C" was given options (1) less than 0.1%, (2) 0.1% – 1%, (3) 1% – 5%, (4) 5% – 10%, (5) 10% – 20%, (6) 20% – 50%, and (7) 50% or higher. Group "Choice D" was provided with options (1) less than 0.01%, (2) 0.01% – 0.1%, (3) 0.1% – 1%, (4) 1% – 5%, (5) 5% – 10%, (6) 10% – 20%, and (7) 20% or higher. Lastly, for group "Choice E", we asked respondents to input a specific number (in percentage) representing their assessment of the probability of infection or CFR, instead of presenting multiple answer options.

2.4. Characteristics of the survey respondents

In addition to their subjective assessment of COVID-19 risk, the main survey on February 2023 gathered information about various individual characteristics of the respondents. We collect basic information including age, gender, place of residence (up to municipality level), education level, and income class. To understand the household structure, we also asked whether the respondents were living with (i) a spouse or partner, (ii) family members over 65, (iii) a child attending college or high school, (iv) a child attending junior high school, (v) a child attending elementary school, and/or (vi) a child attending pre-school or an infant. We also inquired about their smoking habits and medical history. For medical history, we asked if the respondents had any of the following chronic diseases: (1) malignant neoplasms (cancer), (2) cerebrovascular diseases (e.g., cerebral hemorrhage, cerebral infarction), (3) respiratory system diseases, (4) cardiovascular diseases (angina pectoris, myocardial infarction), (5) gastrointestinal diseases (e.g., stomach, intestines, liver, spleen diseases), (6) endocrine system diseases (e.g., diabetes), (7) kidney diseases, (8) hematological diseases (e.g., anemia).

Additionally, we asked about COVID-19-related information, including the vaccination status, the number of past infections, and whether the respondents had any acquaintances—such as family members, relatives, and friends—who died of the virus.

Lastly, we asked respondents which type of media (television, newspaper, internet, SNS, or others) was their primary source of information about COVID-19 in order to examine whether the content and the tone of COVID-19 reporting are associated with people's overall assessment of COVID-19. For those who primarily relied on TVs, we asked about which TV cables they preferred to watch the most (NHK, Nihon, Fuji, TBS, Tokyo, Asahi, or others). For those who primarily read newspapers, we asked about which newspaper they prefer to read (the Asahi, Mainichi, Yomiuri, Sankei, Nikkei, or others). For those who rely on SNS, we inquired which platform they use the most (Twitter, Facebook, Instagram, TikTok, or others).

2.5. Statistical analysis

We apply logistic regressions to examine the relationship between the respondents' individual characteristics and subjective assessments of COVID-19 risks.

For the outcome variables, we utilize respondents' answers on infection (or fatality) risk to generate proxies for risk overestimation and underestimation. Specifically, proxies for risk overestimation are *Infection (Fatality) Over 1%, Infection (Fatality) Over 5%,* and *Infection (Fatality) Over 10%,*[2] which take the value one if the subjective risk of infection (or fatality) is equal to or higher than 1%, 5%, or 10%, respectively, and zero otherwise. Proxies of risk underestimation are *Infection (Fatality) Under 0.001%, Infection (Fatality) Under 0.01%,* and *Infection (Fatality) Under 0.1%*, which take the

[2] In the robustness analysis, we also consider dummy variables based on an alternative threshold for risk overestimation – *Infection (Fatality) Over 20%* (See SI Appendix Figure SI6).

value one if the subjective risk of infection (or fatality) is less than 0.001%, 0.01%, or 0.1%, respectively, and zero otherwise.

For the independent and control variables, we use information on respondent attributes from the survey. The independent variables include *College Graduate*, which equals one if the person has a bachelor's degree or higher, and *High Income*, which equals one if the person has an income including taxes and bonuses in 2022 from 4 million yen (median) or more. The independent variables further include age group, gender, household structure, vaccination status, health situation (represented by *Smoker* and *No Chronic Diseases* dummy variables), proxies for COVID-19-related experiences (*Infected with COVID-19* and *Acquaintances Died of COVID-19*), and the primary media source that respondents refer to. We control for the respondent's residence via the prefecture fixed effects to account for potential variations in the extent of COVID-19 spread and mitigation measures across prefectures. The analyses were conducted using Stata version 17 (College Station, TX, USA), and two-sided p-values <0.05 were considered statistically significant.

3. Results

3.1. Respondent characteristics

Table 1 displays the respondents' characteristics, their corresponding answer options, and the number and percentage of respondents in each option. The 40s-50s and over 60s categories represented the largest segments among the respondents, comprising 33.5% and 42.1% of the total. Male respondents accounted for 48.0%. 42.9% of respondents have a college degree or higher, raising the potential concern that the level of educational attainment among the surveyed population is relatively higher than that of the general population (25.7% according to the 2020 Population Census data). For the income, a significant proportion falls within the range of 2-4 million yen (26.7%). In terms of household composition, the majority of respondents lived with a spouse or partner (59.8%), while some lived with elderly members (21.3%) aged 65 or above, or children (19.8%).

Table 1 Respondent Characteristics

Age	20s-30s	9,762 (24.4%)
	40s-50s	13,388 (33.5%)
	Over 60s	16,850 (42.1%)
Gender	Male	19,194 (48.0%)
	Female	20,806 (52.0%)
Education Level	Non-College Graduate	22,840 (57.1%)
	College Graduate	17,160(42.9%)
Income (In: Ten Thousand Yen)	No Income	2,901 (7.3%)
	Less than 100	2,840 (7.1%)
	100 – Less than 200	4,156 (10.4%)
	200 – Less than 400	10,664 (26.7%)
	400 – Less than 600	7,931 (19.8%)
	600 – Less than 800	4,997 (12.5%)
	800 – Less than 1,000	3,062 (7.7%)
	1,000 or more	3,349 (8.6%)
Living with Spouse/Partner	Yes	23,914 (59.8%)
	No	16,086 (40.2%)
Living with Elderly Member(s)	Yes	8,512 (21.3%)
	No	31,488 (78.7%)
Living with Child(ren)	Yes	7,923 (19.8%)
	No	32,077 (80.2%)
Vaccination	None	5,274 (13.2%)
	Once or twice	4,515(11.2%)

	Three times or more	30,211 (75.5%)
Smoker	Yes	6,880 (17.2%)
	No	33,120 (82.8%)
Chronic Diseases	Yes	6,221 (15.6%)
	No	33,779 (84.5%)
Infected with COVID-19	Yes	9,015 (22.5%)
	No	30,985 (77.5%)
Acquaintance Died of COVID-19	Yes	1,569 (3.9%)
	No	38,431 (96.1%)
Media Source	Television	17,428 (43.6%)
	Newspaper	3,757 (9.4%)
	Internet	14,692 (36.7%)
	SNS	3,134 (7.8%)
	Radio	825 (2.1%)
	Others	164 (0.4%)

Note: N=40,000.

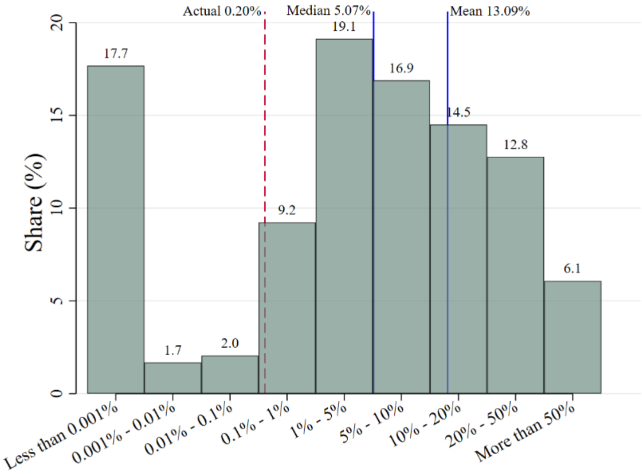
Looking at the vaccination status, 75.5% of respondents reported that they had received three or more vaccine doses. For information on the health situation and the respondents' experiences related to COVID-19, 17.2% of respondents had smoking habits, 15.6% had chronic diseases, 22.5% had a history of COVID-19 infection, and 3.9% had acquaintances who died from COVID-19. Finally, the most important source of information on COVID-19 was TV (43.6%), followed by the internet (36.7%).

3.2. Univariate analysis

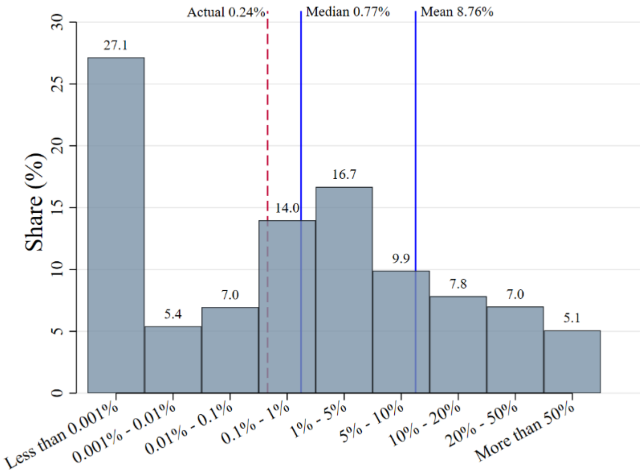
Figure 1 shows the distribution of subjective infection risk (Figure 1(a)) and fatality risk (Figure 1(b)). In the figure, the blue vertical lines represent the statistics on subjective risks (sample mean and median), whereas the red vertical lines represent the actual risks.

Figure 1 Risk Perception toward COVID-19 in February 2023

(a) Infection Risk



(b) Fatality Risk



Note: N(Full Sample) =40,000.

As illustrated in Figure 1(a), many respondents assessed the infection risk as being much higher than the actual infection risk of 0.20%. Among all respondents, 50.2% (16.9+14.5+12.8+6.1) believed their likelihood of contracting COVID-19 within the next month was 5% or higher. Setting a higher threshold, we find that 33.3% (14.5+12.8+6.1) of respondents assessed the infection risk as 10% or higher. Nevertheless, a non-negligible portion of respondents underestimated the infection risk, with 17.7% considering the infection risk as almost zero (less than 0.001%).

Figure 1(b) reveals that respondents tend to overestimate the CFR compared to the actual rate (0.24% during the period from November 2022 to February 2023). Specifically, 29.8% (19.1%) of respondents reported a subjective fatality risk at over 5% (10%), with 9.9% choosing 5%-10%, 7.8% choosing 10%-20%, 7.0% choosing 20%-50%, and 5.1% opting for over 50%. On the other hand, a significant portion of respondents underestimated the CFR, with 27.1% perceiving it as less than 0.001%.

To check the robustness of this finding to alternative presentation of answer options,

Appendix Tables SI1 and SI2 compare the proportion of respondents who overestimated or underestimated COVID risks in the original and supplementary surveys. Even with modified answer options, many respondents overestimated the infection and fatality risks, and a non-negligible number underestimated these risks. Table SI1 shows that 69% (47%) of respondents in the original survey assessed the risk of infection (fatality) to be above 1%, whereas in the supplementary survey the proportion ranged from 51% to 79% (28% to 66%). Meanwhile, Table SI2 shows that 21% (40%) of respondents in the original survey perceived the infection (fatality) risk as less than 0.1%, compared to 20% to 30% (32% to 52%) in the supplementary survey.

Given that the risks of infection and fatality depend on the age, in Table 2 we compute the degree of risk overestimation and underestimation for three age groups. As shown in Table 2(a), the actual infection rates during the survey periods are 0.261%, 0.209%, and 0.148% for the groups "20s-30s", "40s-50s", and "over 60s," respectively. The majority of respondents in all age groups overestimated the infection risk, especially among young persons aged 20s to 30s with 40% reporting an infection rate above 10%. However, the subjective infection rate is "less than 0.001%" in 17-18% of respondents in all three age groups, suggesting that a certain proportion of the Japanese underestimate the infection risks regardless of their ages.

For the case fatality rates, Table 2(b) shows that the actual rate is about 1% for those aged 60 and over, whereas they are much lower for those aged 40s-50s and those aged 20s-30s (0.015% and 0.002%, respectively). The proportion of risk overestimation and underestimation in the group "20s-30s" is almost the same as in the group "40s-50s". However, the proportion of fatality risk overestimation (or underestimation) is considerably higher (or lower) in the group "over 60s" than in other groups.

Table 2 Risk Perception toward COVID-19 by Age Group

(a) Infection Risk

Age Group	N	Actual Infection Rate	Subjective Infection Rate				
			Overestimation			Underestimation	
			Over 5%	Over 10%	Over 20%	Less Than 0.001%	Less Than 0.01%
20s-30s	9,762	0.261%	55.4%	40.0%	24.3%	17.8%	19.7%
40s-50s	13,388	0.209%	53.1%	36.3%	21.3%	17.8%	19.3%
Over 60s	16,850	0.148%	45.0%	27.1%	13.7%	17.5%	19.2%

(b) Fatality Risk

Age Group	N	Actual CFR	Subjective CFR				
			Overestimation			Underestimation	
			Over 5%	Over 10%	Over 20%	Less Than 0.001%	Less Than 0.01%
20s-30s	9,762	0.002%	24.6%	15.7%	9.1%	32.1%	N/A
40s-50s	13,388	0.015%	26.7%	17.8%	10.7%	30.3%	36.0%
Over 60s	16,850	0.997%	35.3%	24.0%	14.8%	21.7%	26.2%

Note: In Table 2(b), N/A means Not Applicable.

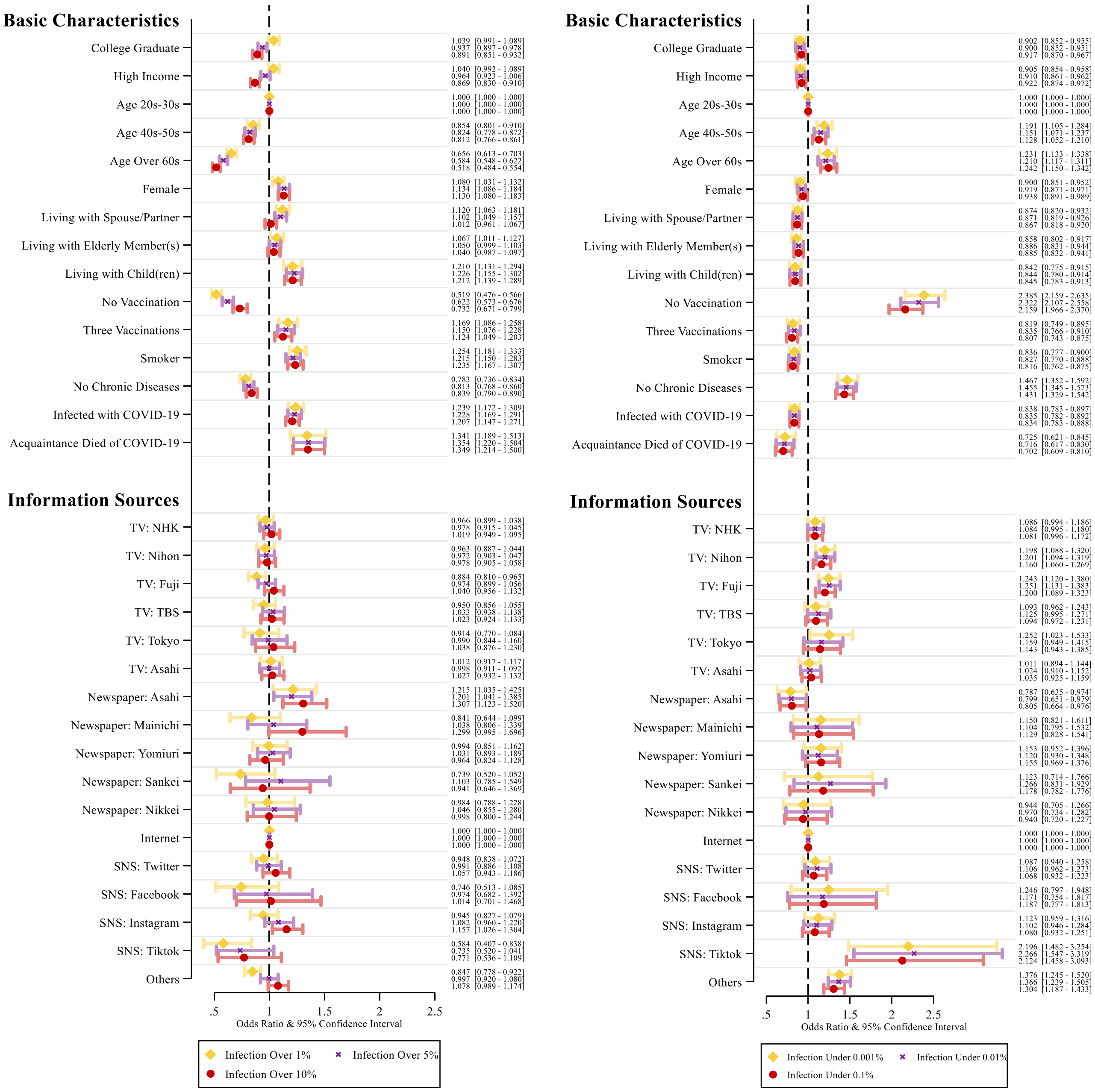
3.3. Multivariate analysis

Figure 2 presents the results of the logistic regression analyses on the overestimation and underestimation of infection risk, using the *Infection Over 1%, 5%, and 10%* and the *Infection Under 0.001%, 0.01%, and 0.1%* as dependent variables.[3] The analysis reveals that several factors are associated with the perceptions of infection risk.

[3] In all figures presenting logistic regression results, the odds ratios on prefecture fixed effects are omitted for simplicity.

Figure 2 Factors Associated with COVID-19 Infection Risk Perception

(a) Risk Overestimation (b) Risk Underestimation



Note: Odds ratios and the corresponding 95% confidence intervals are presented at the right-hand most in the figures. N = 40,000. Alternative specifications of the estimations are shown in SI Appendix Tables SI7.

First, as shown at the top of Figures 2(a) and (b), demographic factors (education, income, age, and gender) are associated with the perception of infection risks. Specifically, when utilizing proxies for very high perception of risk (Figure 2(a)) and very low perception of risk (Figure 2(b)), the odds ratios for *College Graduate* and *High Income* are lower than 1 and statistically significant in most cases. That is, college graduates and high-income individuals are less likely to assess their infection risk as very high or very low. Meanwhile, age is associated with a lower assessment of infection risk, as indicated by the lower (or higher) probability of perceiving such risk as very high (or very low). As for gender, the results show that females perceive the threat of COVID-19 infection as higher than males.

Second, household structure is correlated with the perception of infection risk. In particular, the evidence indicates that individuals living with (i) a spouse or partner, (ii) elderly members, and/or (iii) children are more (or less) likely to perceive a very high (or very low) infection risk, possibly due to close household contact.

Third, the assessment of infection risk is also associated with factors such as health situation, vaccination status, and experiences related to COVID-19. There is a higher (or lower) probability of perceiving infection risk as very high (or very low) among the following groups of people: (i) smokers, (ii) people with chronic health conditions, (iii) those who had received at least three vaccine doses, and (iv) those who had contracted COVID-19 themselves or lost acquaintance(s)—such as family members, relatives, or friends—to the virus.

Finally, as shown at the bottom of Figures 2(a) and (b), media preferences tend to be associated with subjective assessments of infection risk. We find that Asahi newspaper readers are more (or less) likely to overestimate (or underestimate) infection risk compared to Internet users (the base category). In addition, individuals who use Nihon-TV, Fuji-TV, or Tiktok as their primary source of information about COVID-19 are more likely to underestimate infection risk than others.

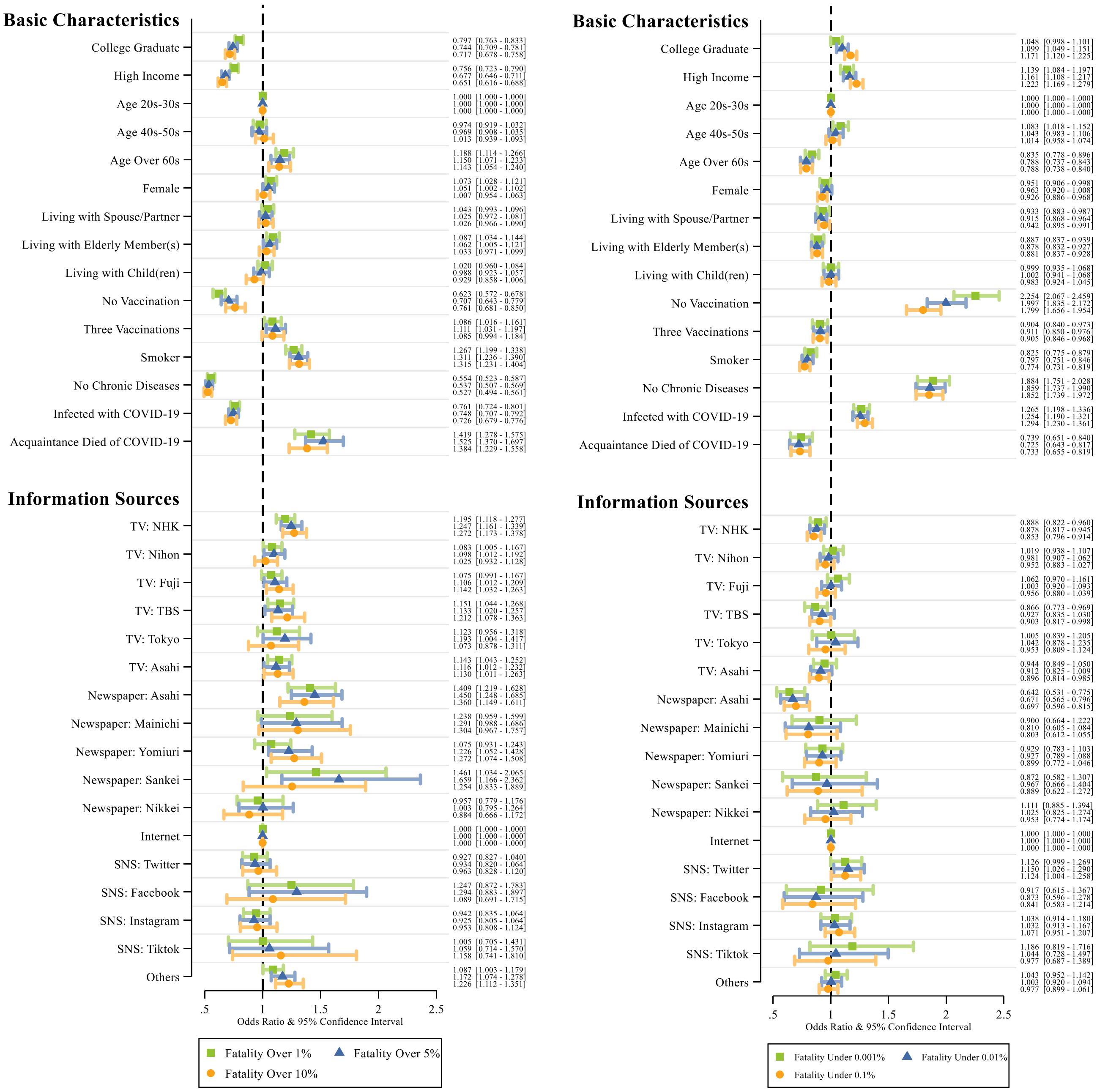
Turning to the perceptions of fatality risk, Figure 3 displays the results from logistic regressions with the outcome variables *Fatality Over 1%, 5%, and 10%* and *Fatality Under 0.001%, 0.01%, and 0.1%*.

As shown in the top of the figures, individuals with higher educational attainment and higher income are less (or more) likely to report a very high (or very low) subjective fatality risk. Individuals aged 60 or above are more (or less) likely to report a very high (or very low) subjective fatality risk than individuals in younger age groups, a finding consistent with the fact that older people face a substantially higher risk of fatality once infected with COVID-19 than younger people.

Next, the following factors—female gender, living with the elderly, completion of three vaccine doses, smoking habits, poor health status, and prior experience of knowing someone who died from COVID-19—are associated with a higher assessment of fatality risk. Meanwhile, individuals with a history of COVID-19 infection are less (or more) likely to report a very high (or very low) fatality risk. This finding could be rationalized if these individuals felt through their own experience that COVID-19 was not as severe as they had imagined prior to infection.

Figure 3 Factors Associated with COVID-19 Fatality Risk Perception

(a) Risk Overestimation (b) Risk Underestimation



Note: Odds ratios and the corresponding 95% confidence intervals are presented at the right-hand most in this figure. N = 40,000.

Finally, Figure 3 demonstrate that information sources play a critical role in people's assessments of fatality risk related to COVID-19. As shown in the left figure, viewers of major television channels in Japan (NHK, Nihon, Fuji, TBS, and Asahi) and readers of three newspapers (Asahi, Yomiuri, and Sankei) are more likely to overestimate fatality risk than those who obtain COVID-19 information mainly from the Internet. Meanwhile, as indicated in the right figure, viewers of NHK TV and TBS TV and readers of Asahi newspaper are less likely to underestimate fatality risk. Twitter users are more likely to underestimate fatality risk; but overall, we did not find a statistically significant difference between fatality risk assessments of Internet users and users of social media platforms.

3.4. Robustness check

We take three approaches to test the robustness of the results presented in the preceding subsection (Multivariate Analysis). The first approach is to perform logistic regression analyses using data from the supplemental survey, in which we elicited risk assessments in various ways. Specifically, for five subsamples ("Choice A" - "Choice E"), we regress proxies for overestimation and underestimation of infection (or fatality) risk on individual characteristics (demographics, health status, personal experiences related to COVID-19) and primary media type (television, newspaper, internet, SNS, or others). We also control for the regional fixed effects. The results are shown in Appendix Figures SI2 and SI3.

The second approach is to employ a linear regression model instead of the logistic regression model. In this analysis, the continuous outcome variables – *Probability of Infection* and *Probability of Fatality* – are the midpoints in responses about subjective risks. For example, if a respondent perceived the infection risk as 50% or higher, the *Probability of Infection* would be 75%. If he/she assessed the risk to be between 20% and 50%, the variable would be assigned a value of 35%, and so on. We use the same set of independent variables as in the logistic regression model. Appendix Figures SI4 and SI5 present the results from the linear regressions using data from our main and supplemental surveys.

The third approach is to use alternative set of outcome variables in the baseline analysis. In the baseline analysis, we utilized *Infection (Fatality) Over 1%, 5%,* and *10%* as proxies for risk overestimation (see Figures 2(a) and 3(a)). Here, we rerun the logistic regressions using *Infection (Fatality) Over 5%, 10%,* and *20%* as outcome variables. We provide the results for the main survey in Appendix Figure SI6 and the supplemental survey in Appendix Figure SI7.

As indicated in Appendix Figures SI2 to SI7, the following findings are robust to alternative methods of eliciting subjective risks and various model specifications. In terms of the subjective infection risk, the evidence suggests that individuals aged 60 or older are less (or more) likely to assess their infection risk as very high (or very low) compared to others. Meanwhile, individuals who have previously contracted COVID-19 are more (or less) likely to assess such risk as very high (or very low). Individuals without pre-existing chronic diseases are less likely to report a very high infection risk. In addition, readers of the Asahi newspaper are more (or less) likely to report a very high (or very low) infection risk than others.

In terms of the subjective fatality risk, we find that individuals without pre-existing chronic diseases are less (or more) likely to have a very high (or very low) assessment of fatality risk. Less educated and low-income individuals are more likely to report a very high fatality risk. People who have contracted COVID-19 are less likely to perceive such risk as very high. Moreover, viewers of NHK-TV and TBS-TV and readers of the Asahi newspaper are more (or less) likely to report a very high (or very low) fatality risk. Viewers of Fuji-TV and Asahi-TV and readers of the Yomiuri newspaper are more likely to report a very high fatality risk than others.

4. Discussion

In this section, we propose two recommendations to improve the communication of risks in the COVID-19 pandemic based on our research.

First, in light of our findings that risk misperceptions exist among Japanese people and that information sources are associated with risk perceptions, it might be helpful for the government to promote regular dissemination of accurate and timely information about COVID-19 risks to the Japanese people. An improved information provision by the government is a particularly important consideration in light of risk communication experience in Japan. According to Ohtake and Kobayashi (2022), there have been delays in COVID-19 risk estimations by experts advising Japanese policymakers. In particular, CFR was often updated about 4-5 months late by the New Coronavirus Infectious Disease Control Headquarters—the key government council that determined general policy toward COVID-19. As CFR substantially declined in early 2022 due to the change in the COVID-19 variant (from Delta to Omicron) and widespread vaccination, such delay in CFR calculation may have influenced the general public's willingness to normalize their lives and thus Japan's socio-economic recovery from the pandemic.

Given this situation, the government may consider incorporating statistical data and/or accompanying simulation scenarios to enhance the correct understanding of risks and better communicate COVID-related risk information. Studies on information provision have shown that people adjust their existing beliefs about COVID-19 in response to expert information (Akesson et al. (2022)), and the combination of statistics and episodic simulations can facilitate effective information communication (Allen et al. (2000), Sinclair et al. (2021)). For example, Sinclair et al. (2021) demonstrate that by requesting respondents to estimate the risks of infection in hypothetical scenarios (such as in a restaurant with 25 people or a party with 100 people) before giving them feedback on the actual risks, more significant changes in risk perceptions and behaviors of respondents can be observed.

Second, taking into account our finding that individuals with different characteristics (age, socio-economic status, health conditions, and history of COVID-19 infection) have different subjective assessments of infection and fatality risks, group-specific risk communication could be effective. For example, our result suggested that individuals with low income or low education are more likely to report very high fatality risk. The government may consider disseminating risk information to these specific groups in more intuitive and more easily understandable ways than they did during the COVID-19 crisis. Interpersonal communication can also play a major role in altering people's risk perceptions (Binder et al. (2011), Kasperson et al. (1988), Kasperson et al. (2022)). Therefore, it might be a good idea for the government to consider organizing discussions and dialogues involving experts and scientists to help adjust people's perceptions of COVID risks.

5. Conclusion

Our large-scale survey has provided several new insights into COVID-19 risk perceptions. First, when comparing perceived risks with actual ones, we find that the majority of respondents overestimated the infection and fatality risks regardless of their age. Second, we nevertheless find that a portion of respondents underestimated such risks. Third, there is heterogeneity in risk perceptions across individual characteristics, including age groups, socio-economic status, health conditions, and history of COVID-19 infection. Finally, our findings highlight that it is important to understand the role of information sources in improving communication about public health policy between governments and the public.

References

Abel, M., Byker, T., & Carpenter, J. (2021). Socially Optimal Mistakes? Debiasing COVID-19 Mortality Risk Perceptions and Prosocial Behavior. *Journal of Economic Behavior & Organization*, *183*, 456–480. https://doi.org/10.1016/j.jebo.2021.01.007

Adachi, M., Murakami, M., Yoneoka, D., Kawashima, T., Hashizume, M., Sakamoto, H., Eguchi, A., Ghaznavi, C., Gilmour, S., Kaneko, S., Kunishima, H., Maruyama-Sakurai, K., Tanoue, Y., Yamamoto, Y., Miyata, H., & Nomura, S. (2022). Factors Associated with the Risk Perception of COVID-19 Infection and Severe Illness: A Cross-Sectional Study in Japan. *SSM - Population Health*, *18*, 101105. https://doi.org/10.1016/j.ssmph.2022.101105

Akesson, J., Ashworth-Hayes, S., Hahn, R., Metcalfe, R., & Rasooly, I. (2022). Fatalism, Beliefs, and Behaviors During the COVID-19 Pandemic. *Journal of Risk and Uncertainty*, *64*(2), 147–190. https://doi.org/10.1007/s11166-022-09375-y

Allen, M., Bruflat, R., Fucilla, R., Kramer, M., McKellips, S., Ryan, D. J., & Spiegelhoff, M. (2000). Testing the Persuasiveness of Evidence: Combining Narrative and Statistical Forms. *Communication Research Reports*, *17*(4), 331–336. https://doi.org/10.1080/08824090009388781

Binder, A. R., Scheufele, D. A., Brossard, D., & Gunther, A. C. (2011). Interpersonal Amplification of Risk? Citizen Discussions and Their Impact on Perceptions of Risks and Benefits of a Biological Research Facility. *Risk Analysis*, *31*(2), 324–334. https://doi.org/10.1111/j.1539-6924.2010.01516.x

BOJ. (2023). Consumption Activity Index. https://www.boj.or.jp/en/research/research-_data/cai/index.htm

Brewer, N. T., Chapman, G. B., Gibbons, F. X., Gerrard, M., McCaul, K. D., & Weinstein, N. D. (2007). Meta-Analysis of the Relationship Between Risk Perception and Health Behavior: The Example of Vaccination. *Health Psychology*, *26*(2), 136–145. https://doi.org/10.1037/0278-6133.26.2.136

Bruine De Bruin, W., & Bennett, D. (2020). Relationships Between Initial COVID-19 Risk Perceptions and Protective Health Behaviors: A National Survey. *American Journal of Preventive Medicine*, *59*(2), 157–167. https://doi.org/10.1016/j.amepre.2020.05.001

Bundorf, M. K., DeMatteis, J., Miller, G., Polyakova, M., Streeter, J. L., & Wivagg, J. (2023). Risk Perceptions and Private Protective Behaviors: Evidence from COVID-19 Pandemic. *Review of Economics and Statistics*, 1–40. https://doi.org/10.1162/rest_a_01309

Cipolletta, S., Andreghetti, G. R., & Mioni, G. (2022). Risk Perception towards COVID-19: A Systematic Review and Qualitative Synthesis. *International Journal of Environmental Research and Public Health*, *19*(8), 4649. https://doi.org/10.3390/ijerph19084649

Dryhurst, S., Schneider, C. R., Kerr, J., Freeman, A. L. J., Recchia, G., Van Der Bles, A. M., Spiegelhalter, D., & Van Der Linden, S. (2020). Risk Perceptions of COVID-19 Around the World. *Journal of Risk Research*, *23*(7–8), 994–1006. https://doi.org/10.1080/13669877.2020.1758193

Dyer, M. L., Sallis, H. M., Khouja, J. N., Dryhurst, S., & Munafò, M. R. (2022). Associations Between COVID-19 Risk Perceptions and Mental Health, Wellbeing, and Risk Behaviours. *Journal of Risk Research*, *25*(11–12), 1372–1394. https://doi.org/10.1080/13669877.2022.2127849

Ferrer, R. A., & Klein, W. M. P. (2015). Risk Perceptions and Health Behavior. *Current Opinion in Psychology*, *5*, 85-89. https://doi.org/10.1016/j.copsyc.2015.03.012

Garfin, D. R., Fischhoff, B., Holman, E. A., & Silver, R. C. (2021). Risk Perceptions and Health Behaviors as COVID-19 Emerged in the United States: Results From a Probability-Based Nationally Representative Sample. *Journal of Experimental Psychology: Applied*, *27*(4), 584–598. https://doi.org/10.1037/xap0000374

Gollust, S. E., Vogel, R. I., Rothman, A., Yzer, M., Fowler, E. F., & Nagler, R. H. (2020). Americans' Perceptions of Disparities in COVID-19 Mortality: Results From a Nationally-Representative Survey. *Preventive Medicine*, *141*, 106278. https://doi.org/10.1016/j.ypmed.2020.106278

Graso, M. (2022). The New Normal: COVID-19 Risk Perceptions and Support for Continuing Restrictions Past Vaccinations. *PLOS ONE*, *17*(4), e0266602. https://doi.org/10.1371/journal.pone.0266602

Huynh, T. L. D. (2020). The COVID-19 Risk Perception: A Survey on Socioeconomics and Media Attention. *Economics Bulletin*, *40*(1), 758–764.

IMF. (2023). World Economic Outlook (April 2023). https://www.imf.org/external/data-mapper/datasets/WEO

Kasperson, R. E., Renn, O., Slovic, P., Brown, H. S., Emel, J., Goble, R., Kasperson, J. X., & Ratick, S. (1988). The Social Amplification of Risk: A Conceptual Framework. *Risk Analysis*, *8*(2), 177–187. https://doi.org/10.1111/j.1539-6924.1988.tb01168.x

Kasperson, R. E., Webler, T., Ram, B., & Sutton, J. (2022). The Social Amplification of Risk Framework: New Perspectives. *Risk Analysis*, *42*(7), 1367–1380. https://doi.org/10.1111/risa.13926

MHLW. (2023). Visualizing the Data: Information on COVID-19 Infections.

https://covid19.mhlw.go.jp/en/

MIAC. (2023). Population Estimates. https://www.stat.go.jp/data/jinsui/

Ohtake, F. & Kobayashi, K. (2022). Opinion on Data on New Coronavirus Infections. https://note.com/fohtake/n/n88f5ba75f30f

Sato, M., Kinoshita, S., & Ida, T. (2022). Subjective Risk Valuation and Behavioral Change: Evidence From COVID-19 in the U.K. and Japan. *Discussion Paper No. E-22-011*. Graduate School of Economics, Kyoto University. http://www.econ.kyoto-u.ac.jp/dp/papers/e-22-011.pdf

Savadori, L., & Lauriola, M. (2022). Risk Perceptions and COVID-19 Protective Behaviors: A Two-Wave Longitudinal Study of Epidemic and Post-epidemic Periods. *Social Science & Medicine*, *301*, 114949. https://doi.org/10.1016/j.socscimed.2022.114949

Shobako, N. (2022). Lessons From the Health Policies for Children During the Pandemic in Japan. *Frontiers in Public Health*, *10*, 1015955. https://doi.org/10.3389/fpubh.2022.1015955

Sinclair, A. H., Hakimi, S., Stanley, M. L., Adcock, R. A., & Samanez-Larkin, G. R. (2021). Pairing Facts with Imagined Consequences Improves Pandemic-Related Risk Perception. *Proceedings of the National Academy of Sciences*, *118*(32), e2100970118. https://doi.org/10.1073/pnas.2100970118

Takaku, R., Shobako, N., & Nakata, T. (2023). Three Years of Covid-19-Related School Restrictions and Children's Mental Health in Japan. Preprint at https://doi.org/10.21203/rs.3.rs-3144141/v1

Vai, B., Cazzetta, S., Ghiglino, D., Parenti, L., Saibene, G., Toti, M., Verga, C., Wykowska, A., & Benedetti, F. (2020). Risk Perception and Media in Shaping Protective

Behaviors: Insights From the Early Phase of COVID-19 Italian Outbreak. *Frontiers in Psychology*, *11*, 563426. https://doi.org/10.3389/fpsyg.2020.563426

Wise, T., Zbozinek, T. D., Michelini, G., Hagan, C. C., & Mobbs, D. (2020). Changes in Risk Perception and Self-Reported Protective Behaviour During the First Week of the COVID-19 Pandemic in the United States. *Royal Society Open Science*, *7*(9), 200742. https://doi.org/10.1098/rsos.200742

Author Contributions

Conceptualization: TN, RT, and AC. **Data curation:** RT, AC, and TLN. **Formal analysis:** RT and TLN. **Investigation:** RT and TN. **Methodology:** RT and TN. **Project administration:** TN. **Supervision:** TN and RT. **Visualization:** RT and TLN. **Writing – original draft:** RT and TLN. **Writing – review & editing:** TN, RT, and TLN.

Competing interests

The authors declare no competing interests.

Consent for publication

Not required

Ethics approval

This study was approved by the Ethics Committee of University of Tokyo (22-388).

Data availability statement

Due to restrictions on the availability of data due to consent agreements for data security as well as IRB approval, data is available on request.

Supplementary Information (SI) Appendix

Title: COVID-19 Risk Perceptions in Japan: A Cross Sectional Study

Authors: Asako Chiba, Taisuke Nakata, Thuy Linh Nguyen, and Reo Takaku

Included Files

- Supplementary Tables 1 and 2
- Supplementary Figures 1-7

Table SI1 Self-reported CFRs in Main and Supplemental Survey – Overestimation

	Original Survey in February 2023	Supplemental Survey in April 2023				
		Choice A	Choice B	Choice C	Choice D	Choice E
Panel A. Infection Risk (Actual infection risk as of February 2023: 0.20%)						
More than 10%	33.3%	29.3%	11.9%	28.0%	17.8%	54.4%
More than 5%	50.2%	46.8%	26.5%	47.2%	32.8%	69.9%
More than 1%	69.4%	69.0%	50.9%	68.5%	57.3%	79.2%
Panel B Fatality Risk (Actual fatality risk as of February 2023: 0.24%)						
More than 10%	19.9%	16.7%	7.2%	16.6%	10.4%	29.6%
More than 5%	29.8%	27.0%	14.7%	28.6%	18.9%	42.6%
More than 1%	46.5%	44.0%	27.5%	46.6%	33.9%	65.6%
Number of Observations	40,000	2,002	2,002	2,002	2,002	2,002

Note: On the supplemental survey in April 2023, we provided group "Choice A" with the same options as in the original survey. Meanwhile, for groups B, C, and D, each group was given seven alternative options. Lastly, for group "Choice E", we omitted the options and instead asked respondents to input a specific number (in percentage) representing their assessment of the probability of infection or CFR.

Table SI2 Self-reported CFRs in Main and Supplemental Survey – Underestimation

	Original Survey in February 2023	Supplemental Survey in April 2023				
		Choice A	Choice B	Choice C	Choice D	Choice E
Panel A. Infection Risk						
Less than 0.001%	17.7%	14.6%	19.9%	-	-	19.9%
Less than 0.01%	19.4%	16.6%	24.1%	-	21.6%	19.9%
Less than 0.1%	21.4%	19.6%	30.4%	20.8%	27.2%	20.2%
Panel B Fatality Risk						
Less than 0.001%	27.1%	25.9%	34.4%	-	-	30.2%
Less than 0.01%	32.6%	32.2%	42.7%	-	38.9%	30.8%
Less than 0.1%	39.5%	40.1%	52.3%	35.4%	49.7%	32.0%
Number of Observations	40,000	2,002	2,002	2,002	2,002	2,002

Note: On the supplemental survey in April 2023, we provided group “Choice A” with the same options as in the original survey. Meanwhile, for groups B, C, and D, each group was given seven alternative options. Lastly, for group “Choice E”, we omitted the options and instead asked respondents to input a specific number (in percentage) representing their assessment of the probability of infection or CFR.

Figure SI1 Key Indicators on COVID-19 Infections and the Timing of Our Survey

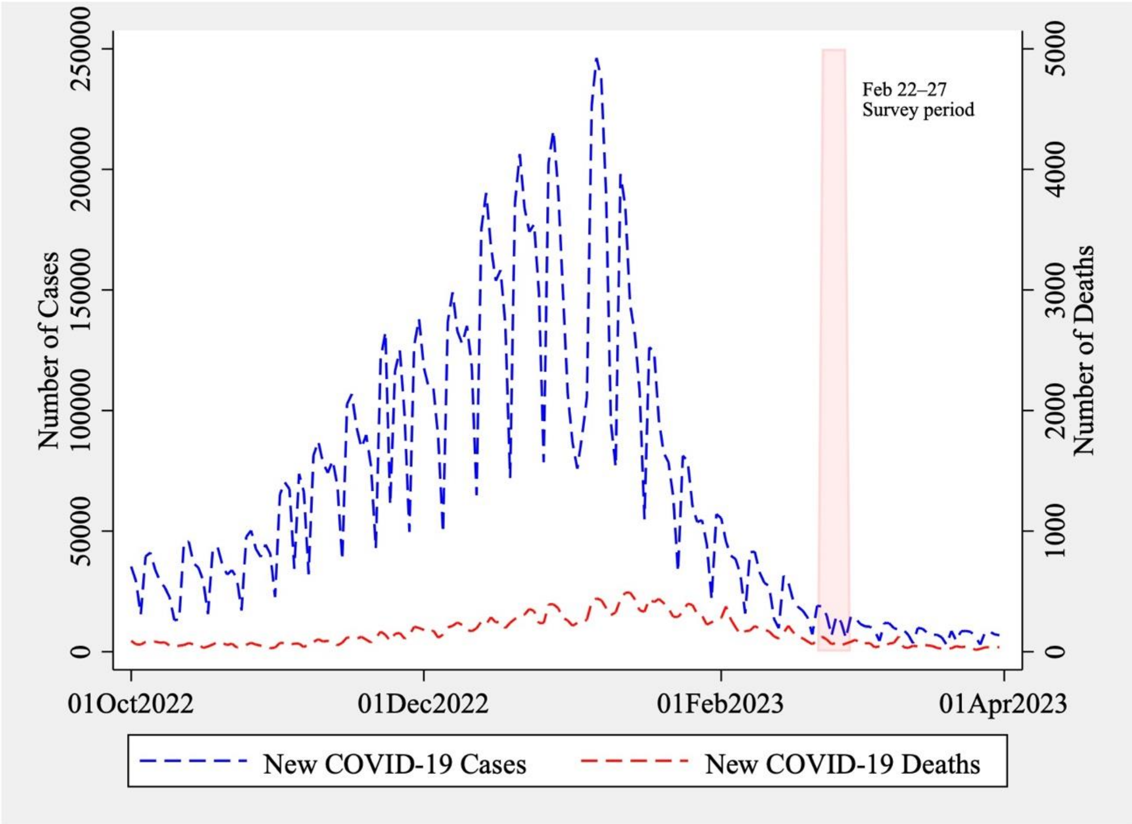
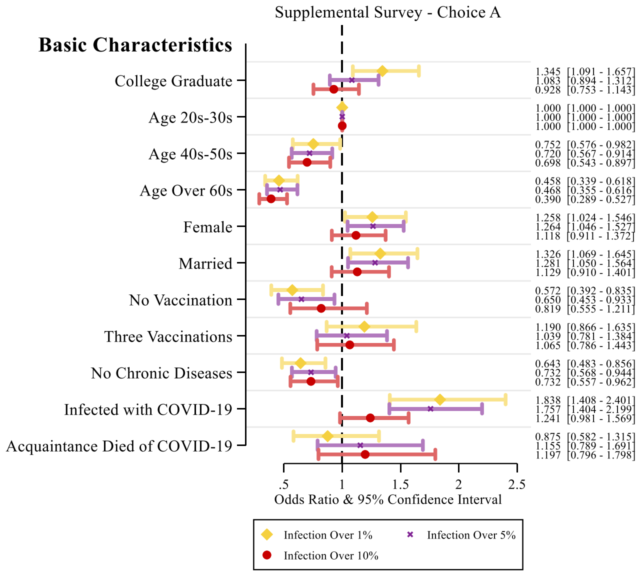


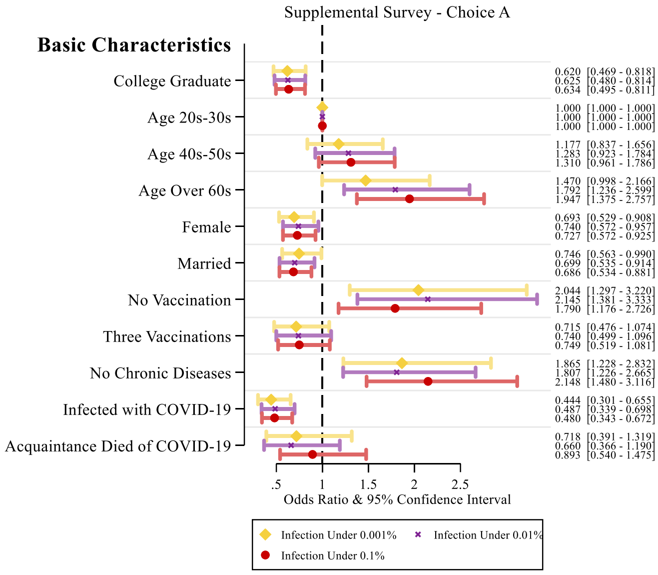
Figure SI2 Factors Associated with Infection Risk Perception – Supplemental Survey

A. Group Choice A

(a) Risk Overestimation

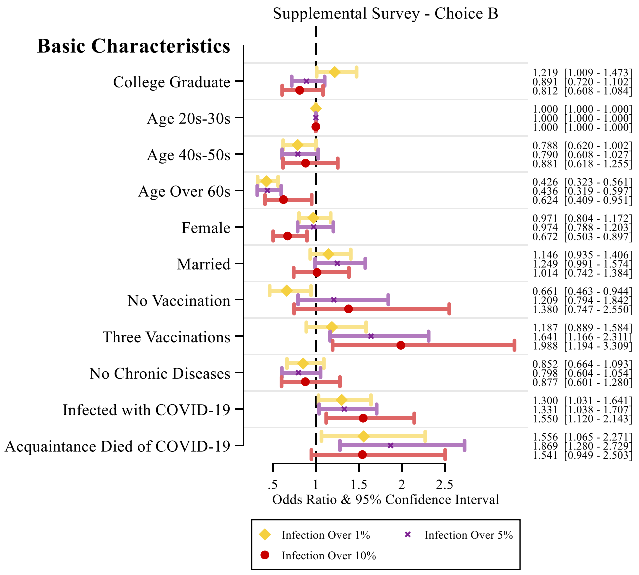


(b) Risk Underestimation

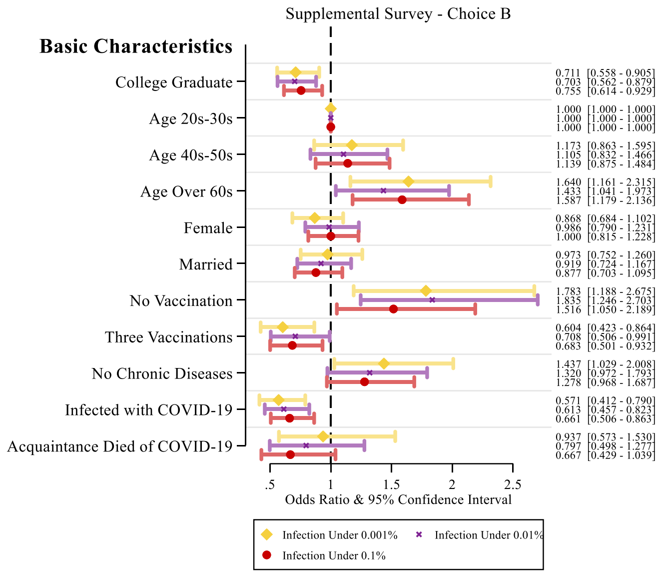


B. Group Choice B

(a) Risk Overestimation

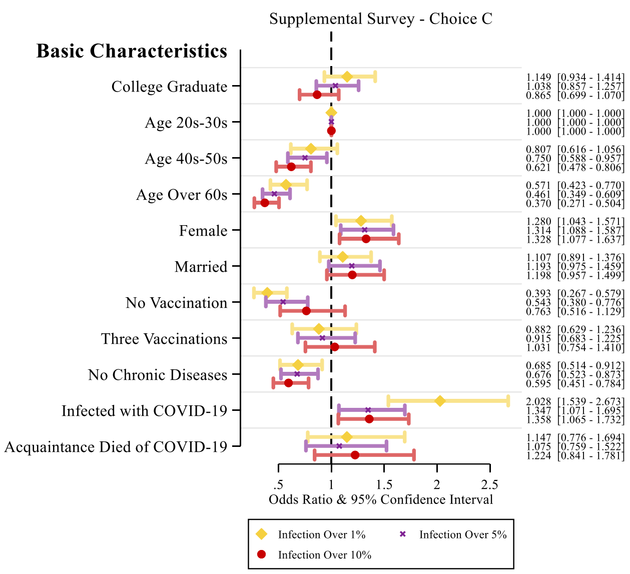


(b) Risk Underestimation

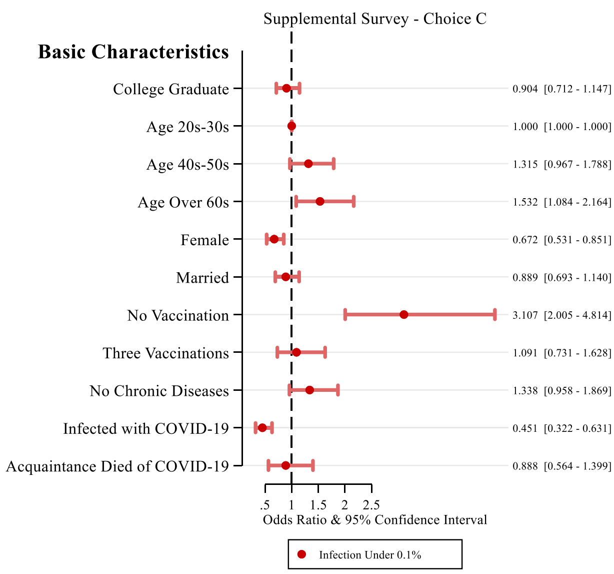


C. Group Choice C

(a) Risk Overestimation

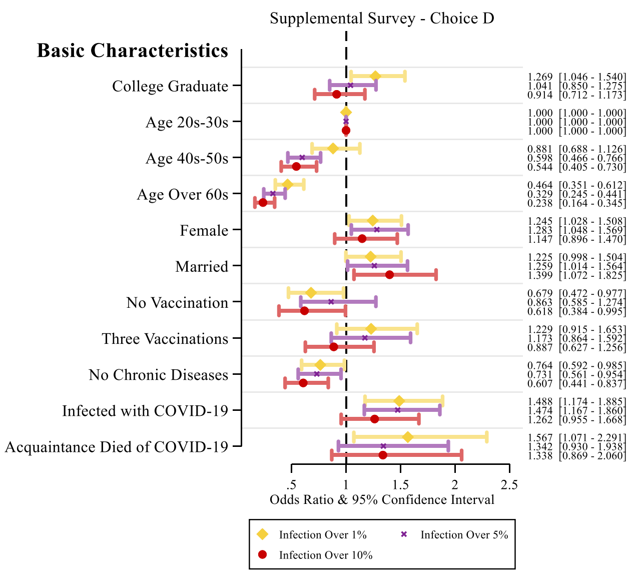


(b) Risk Underestimation

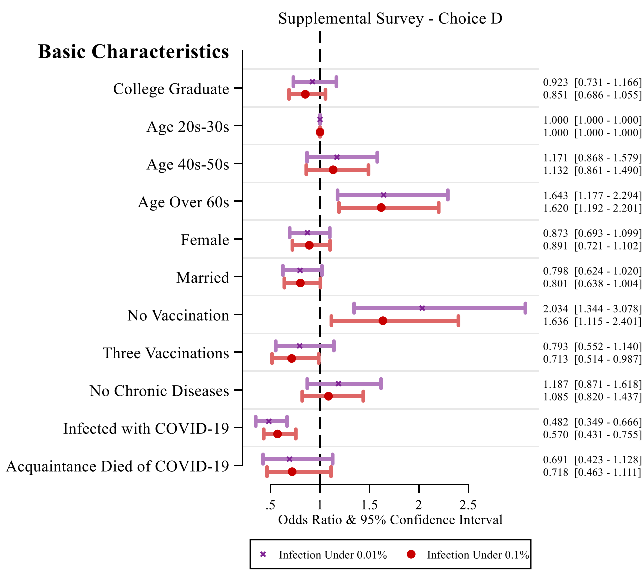


D. Group Choice D

(a) Risk Overestimation

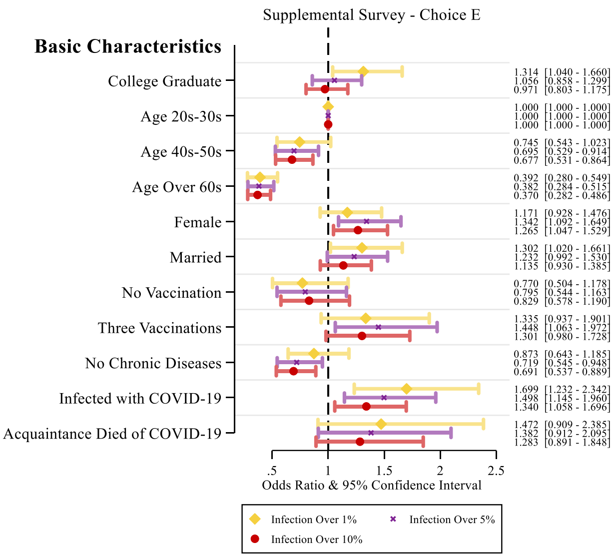


(b) Risk Underestimation

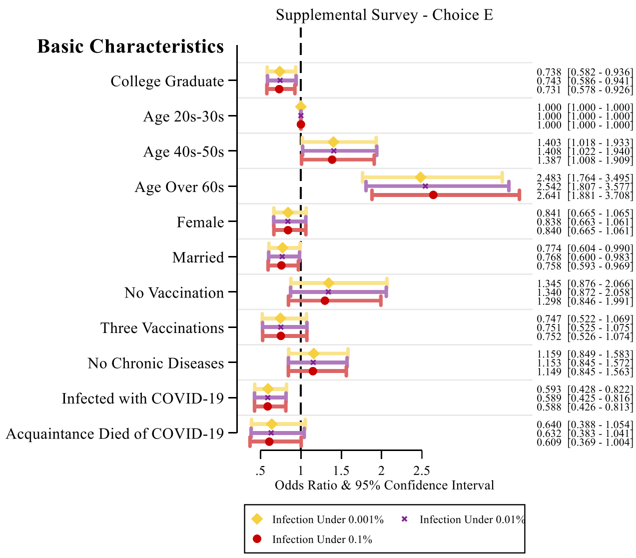


E. Group Choice E

(a) Risk Overestimation



(b) Risk Underestimation

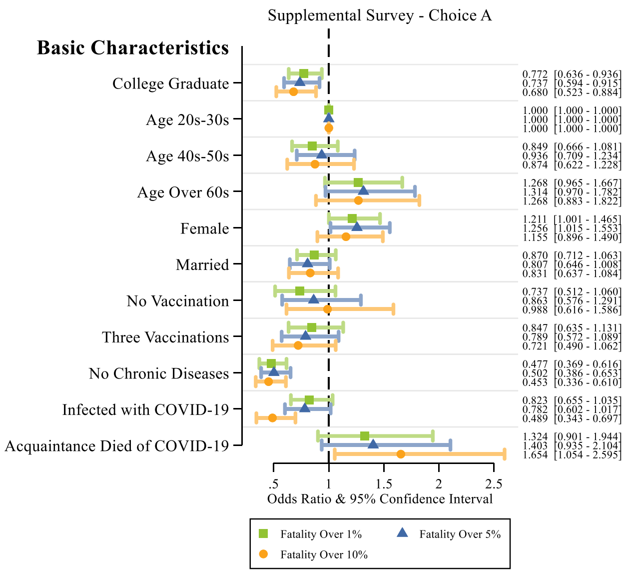


Note: N(Each group) = 2,002. In the regressions, we control for the media source and regional fixed effects.

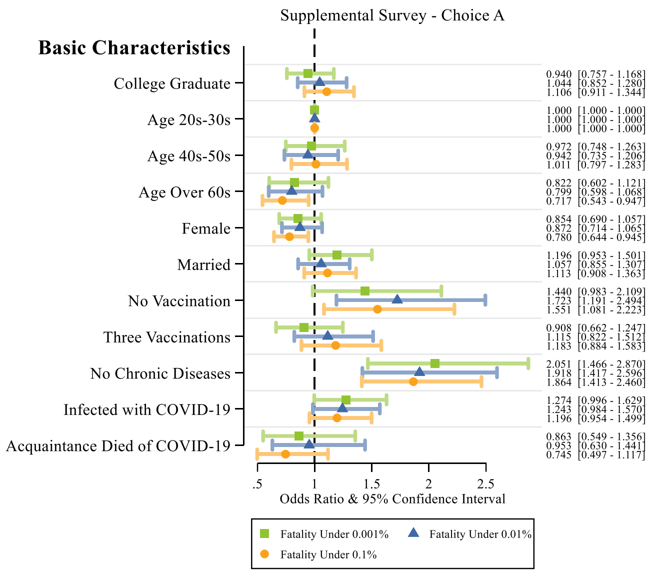
Figure SI3 Factors Associated with Fatality Risk Perception – Supplemental Survey

A. Group Choice A

(a) Risk Overestimation

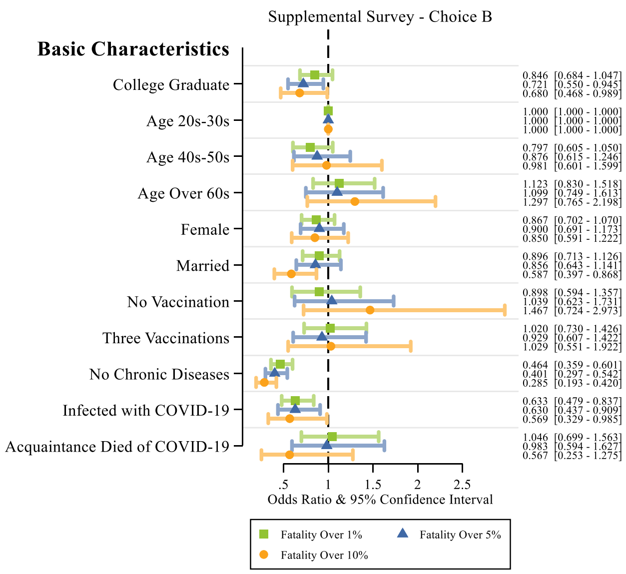


(b) Risk Underestimation

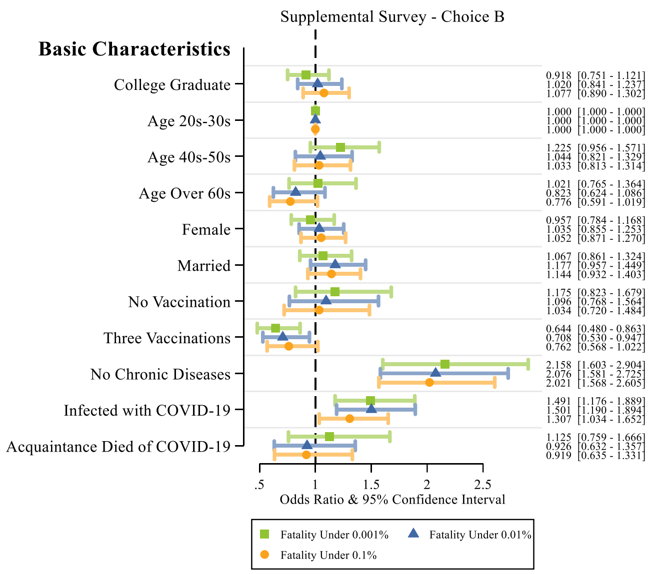


B. Group Choice B

(a) Risk Overestimation

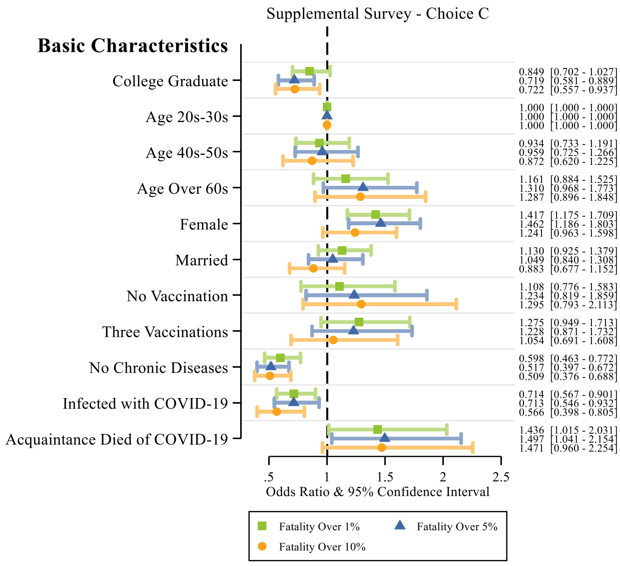


(b) Risk Underestimation

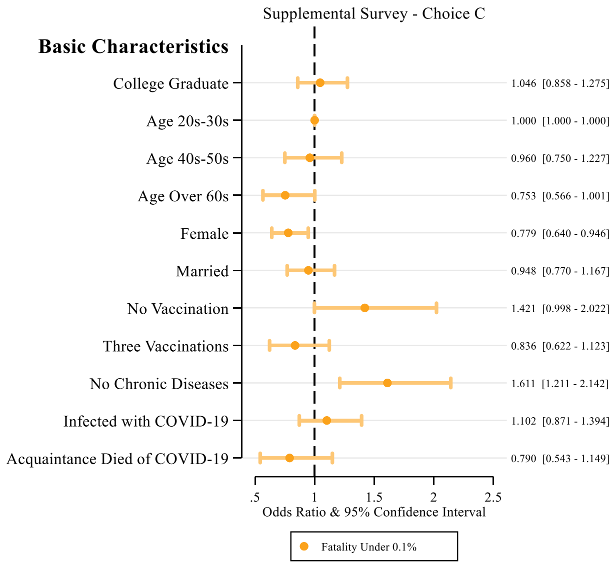


C. Group Choice C

(a) Risk Overestimation

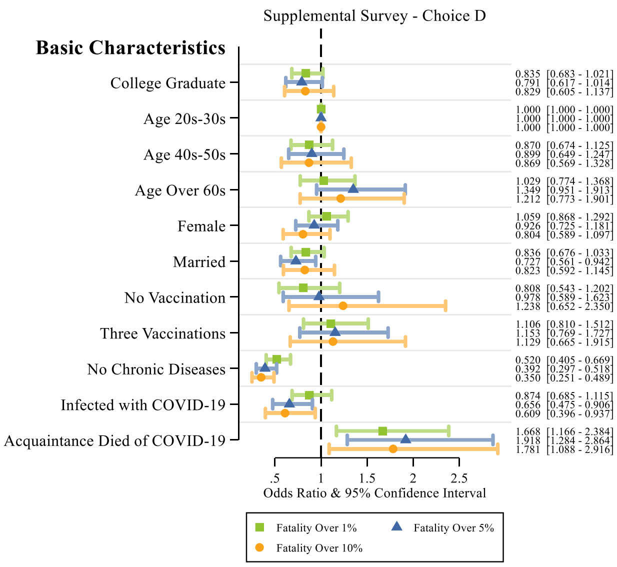


(b) Risk Underestimation

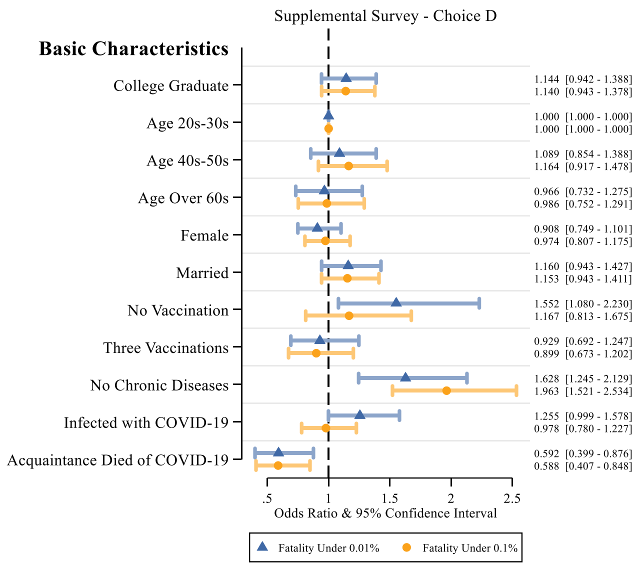


D. Group Choice D

(a) Risk Overestimation

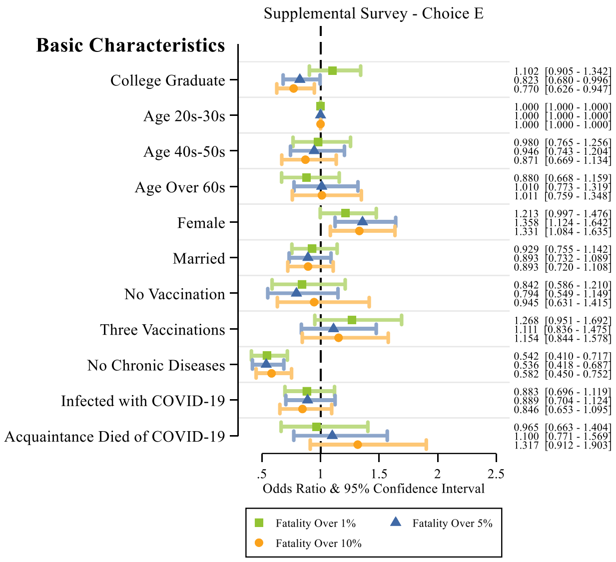


(b) Risk Underestimation

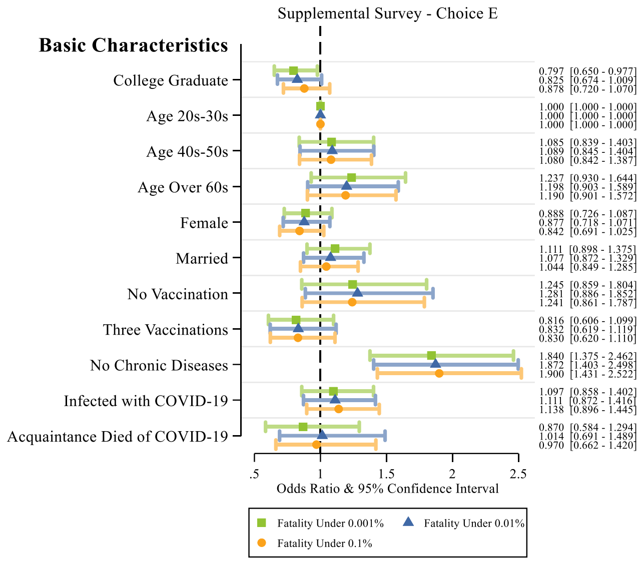


E. Group Choice E

(a) Risk Overestimation

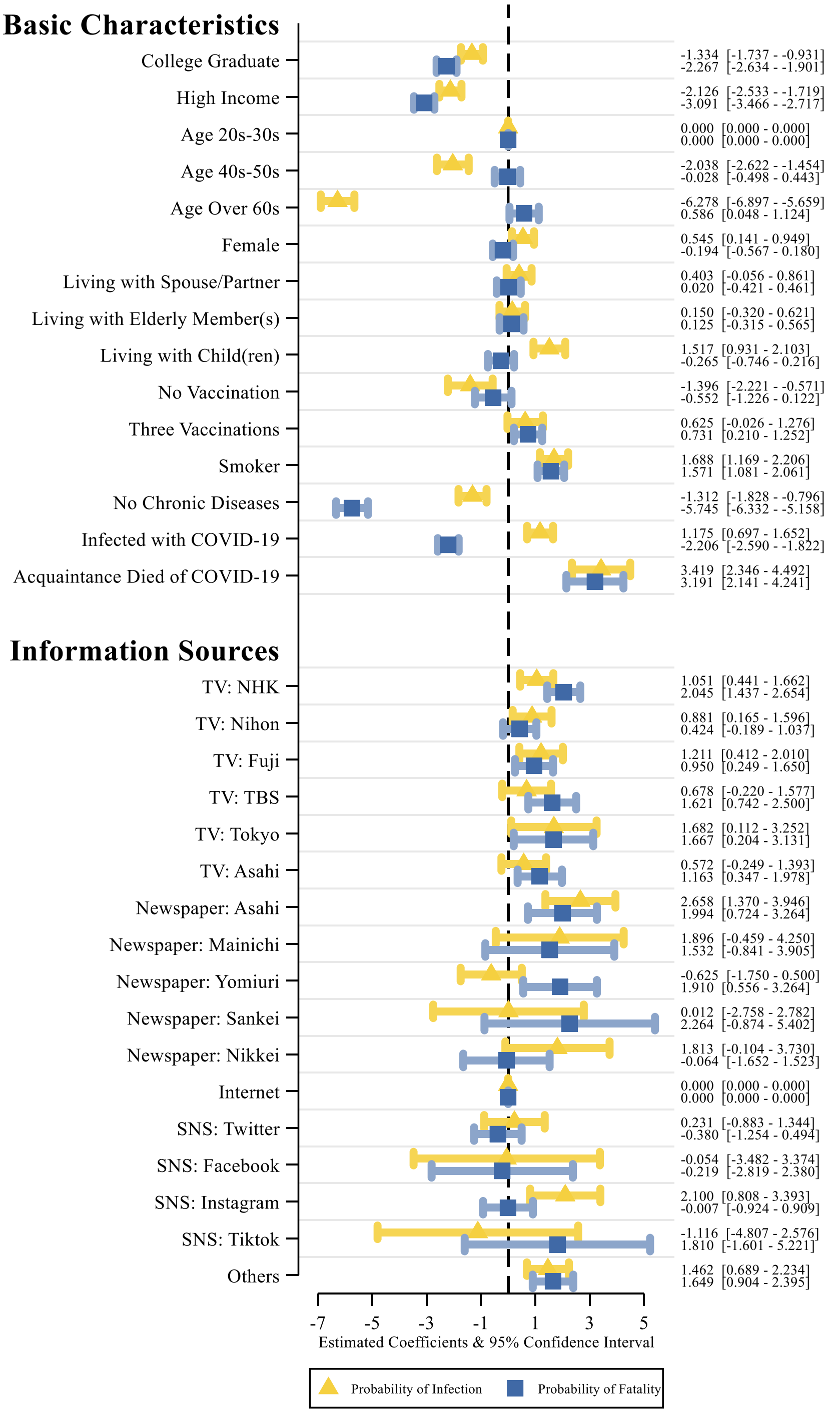


(b) Risk Underestimation



Note: N(Each group) = 2,002. In the regressions, we control for the media source and regional fixed effects.

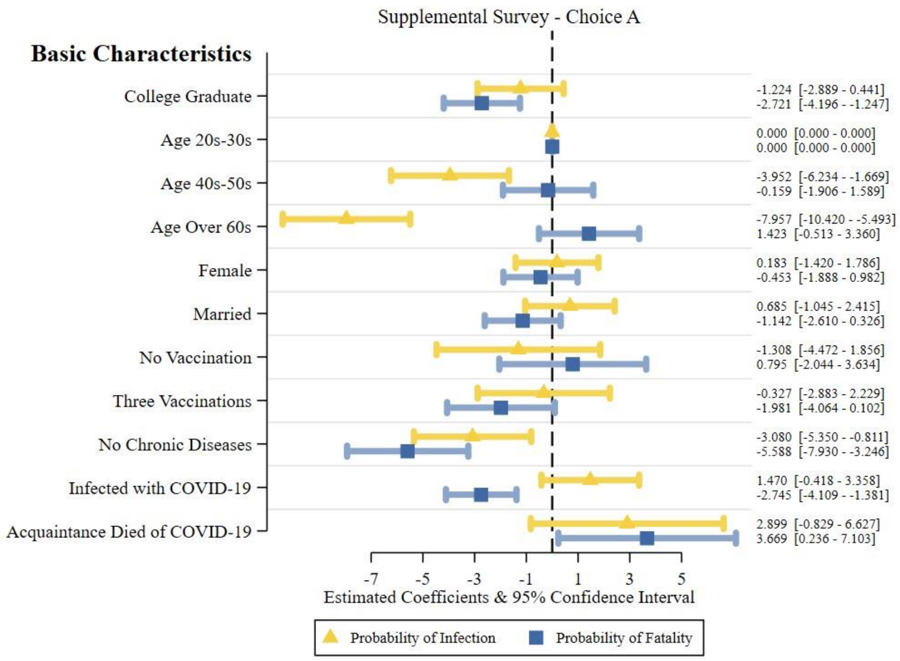
Figure SI4 Results from Linear Regression – Main Survey



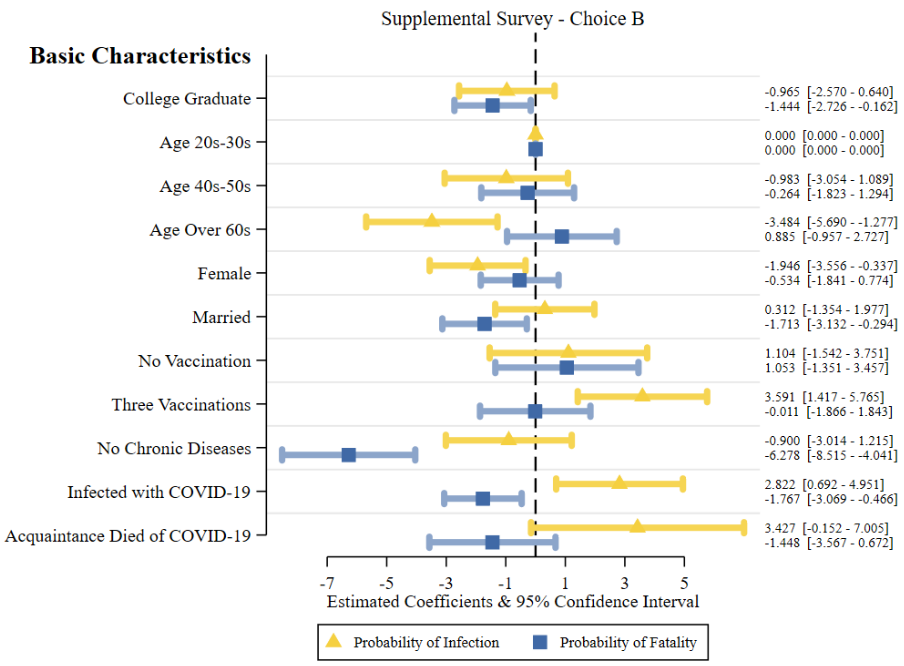
Note: Coefficients and the corresponding 95% confidence intervals are presented at the right-hand most in this figure. N = 40,000.

Figure SI5 Results from Linear Regression – Supplemental Survey

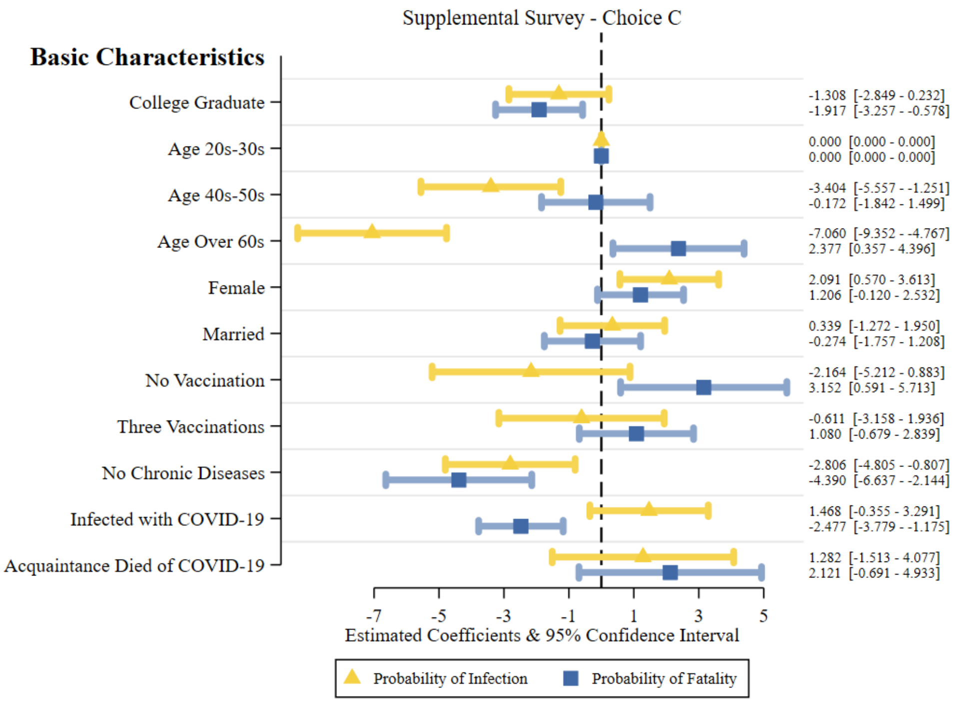
a) Group Choice A



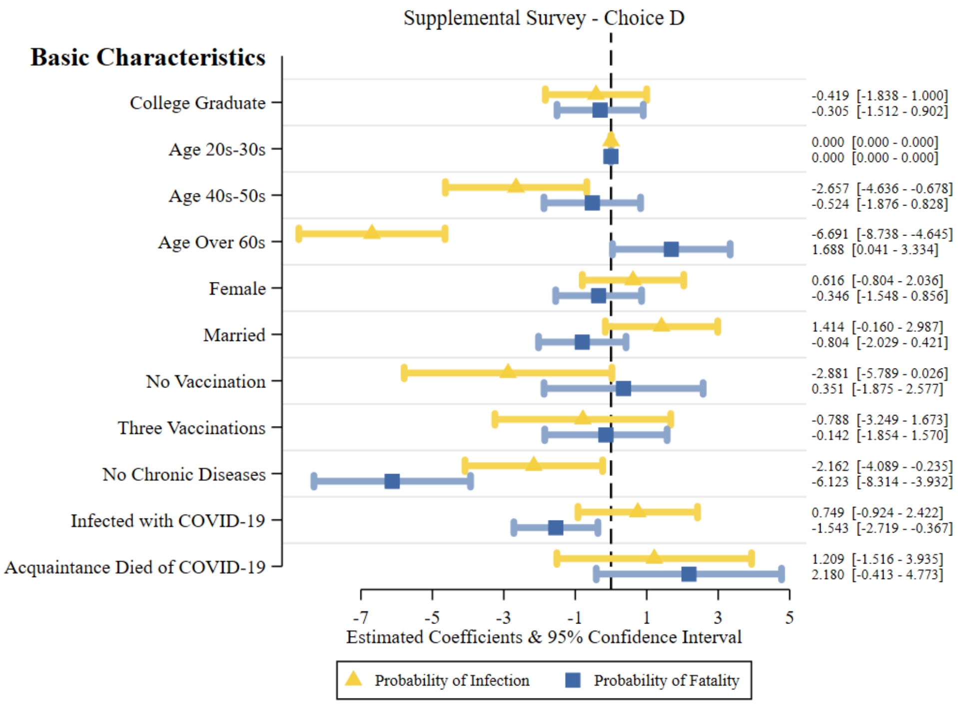
b) Group Choice B



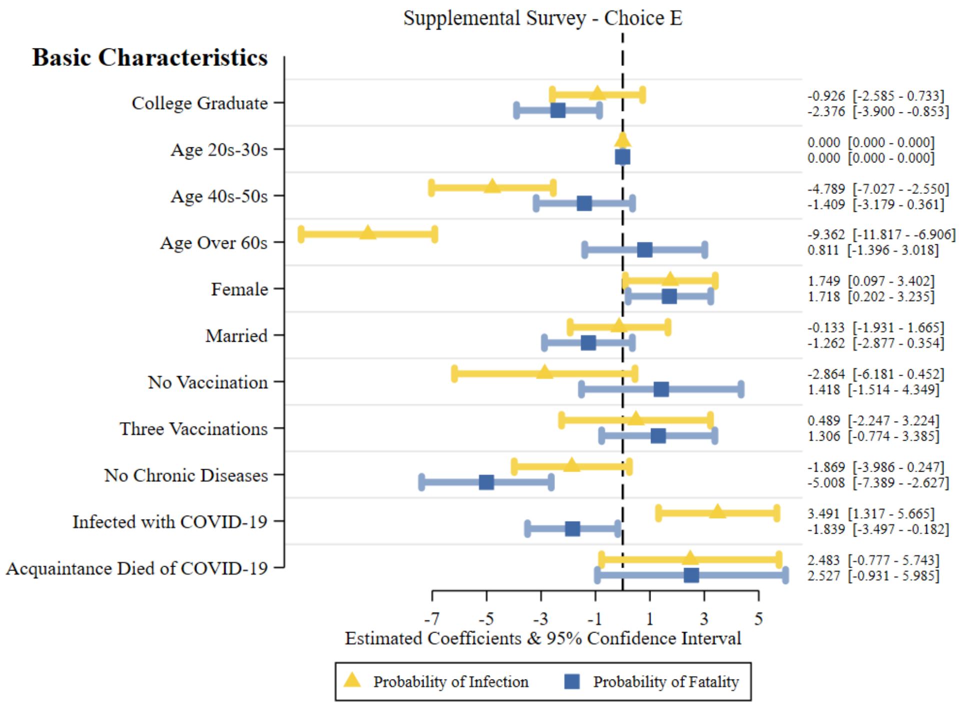
c) Group Choice C



d) Group Choice D



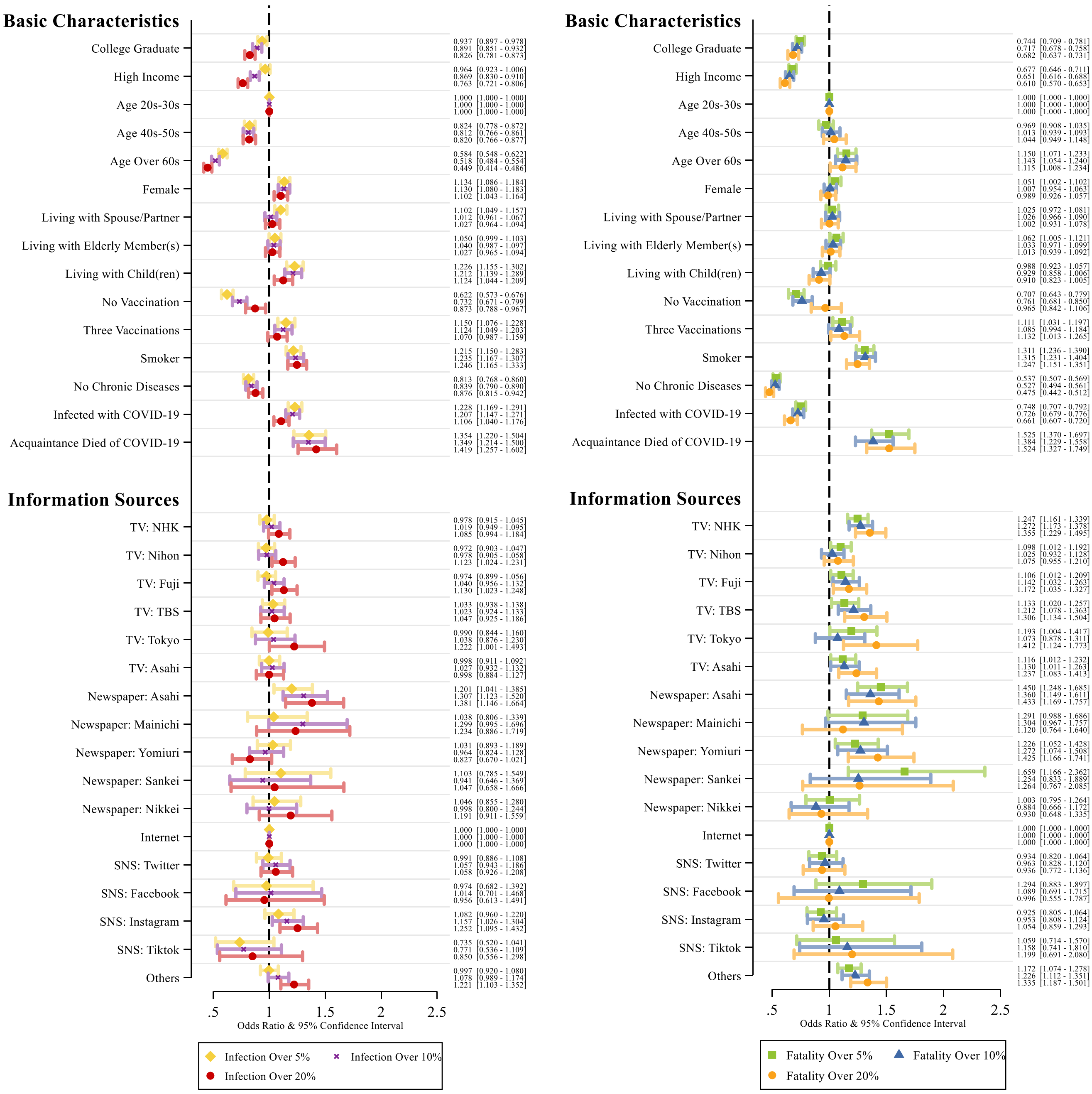
e) Group Choice E



Note: N(Each group) = 2,002. Coefficients and the corresponding 95% confidence intervals are presented at the right-hand most in this figure. In the regressions, we control for the media source and regional fixed effects.

Figure SI6 Risk Overestimation: Alternative Thresholds (Main Survey)

(a) Infection Risk (b) Fatality Risk

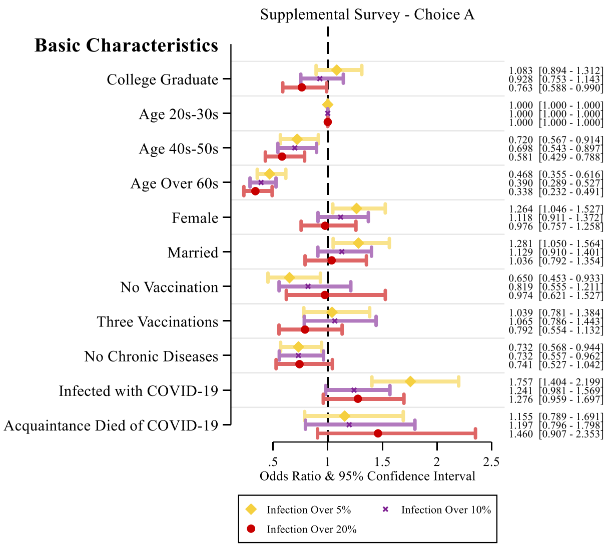


Note: N = 40,000. In the regressions, we also control for prefecture fixed effects.

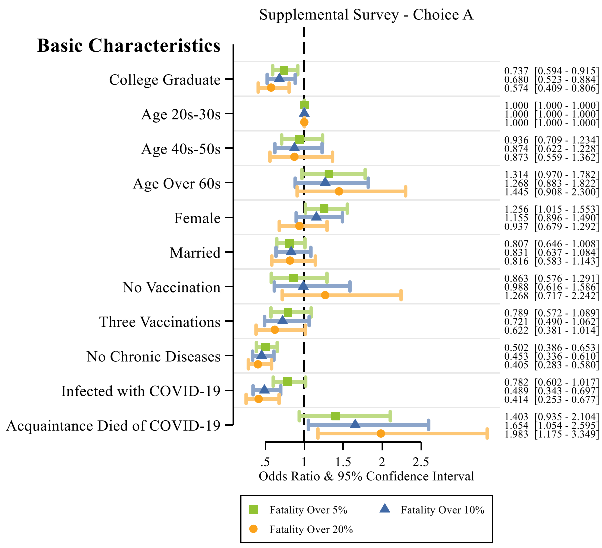
Figure SI7 Risk Overestimation: Alternative Thresholds (Supplemental Survey)

A. Group Choice A

(a) Infection Risk

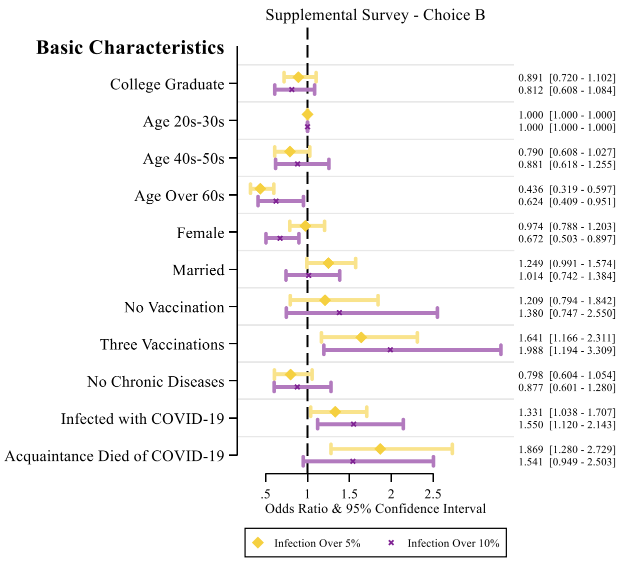


(b) Fatality Risk

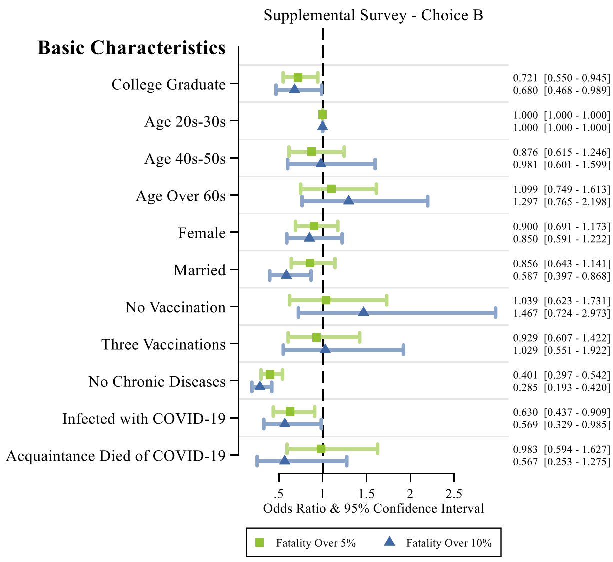


B. Group Choice B

(a) Infection Risk

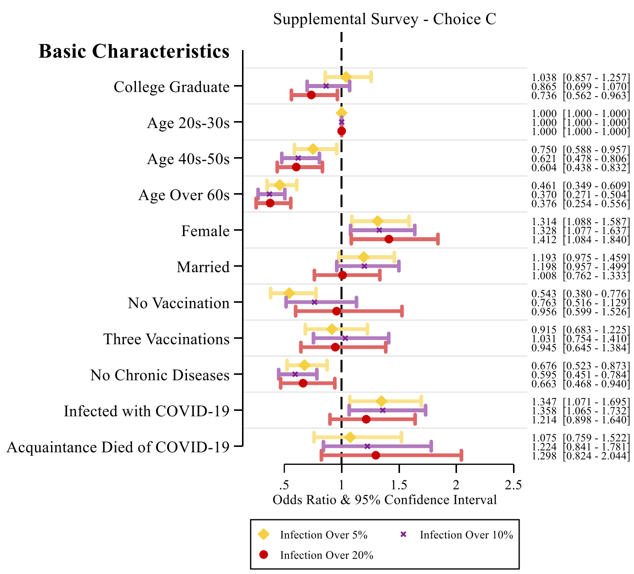


(b) Fatality Risk

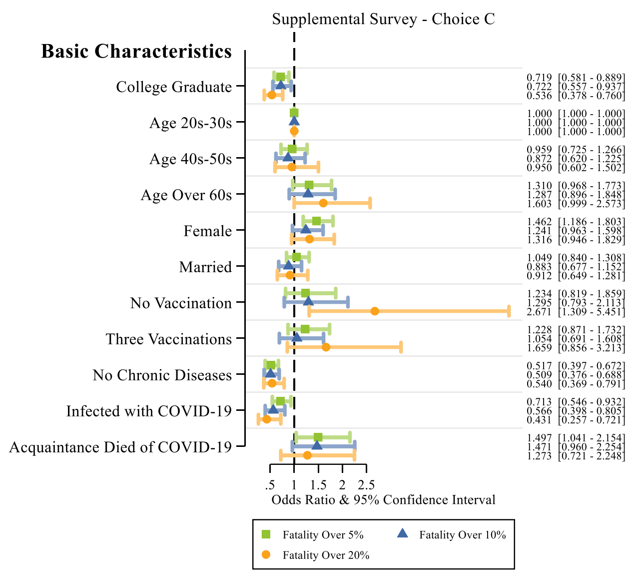


C. Group Choice C

a) Infection Risk

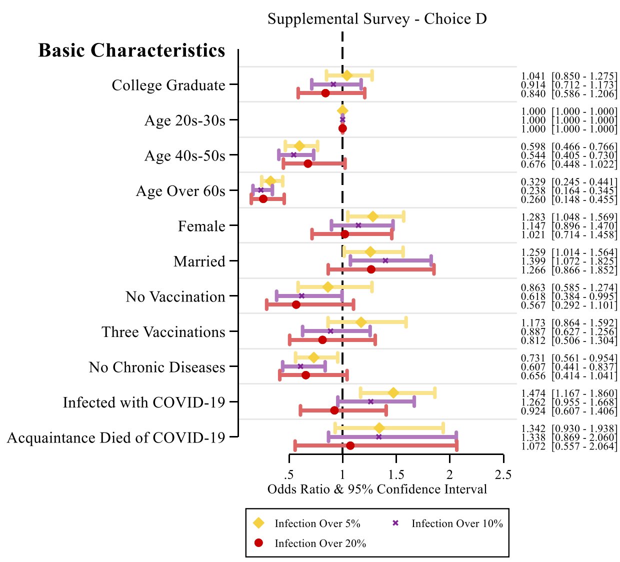


(b) Fatality Risk

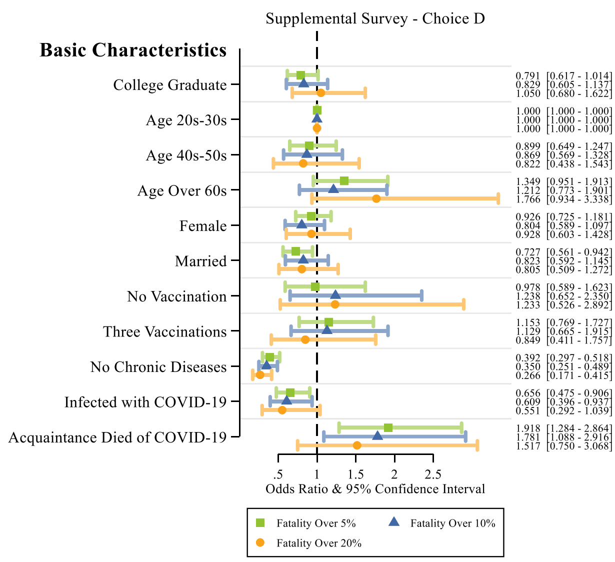


D. Group Choice D

a) Infection Risk

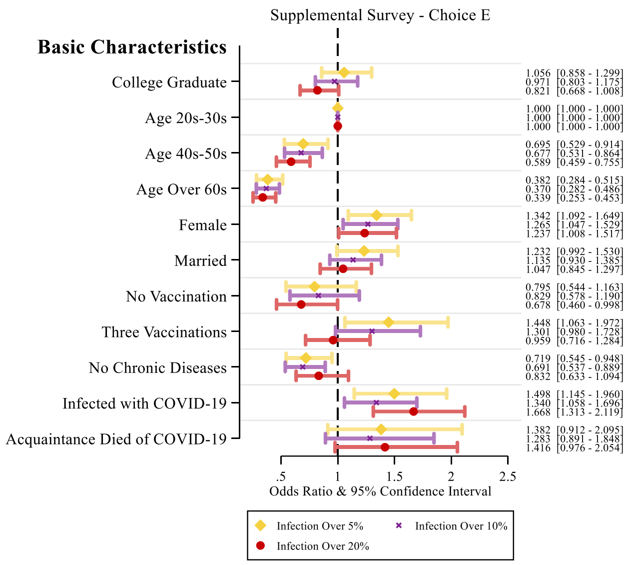


(b) Fatality Risk

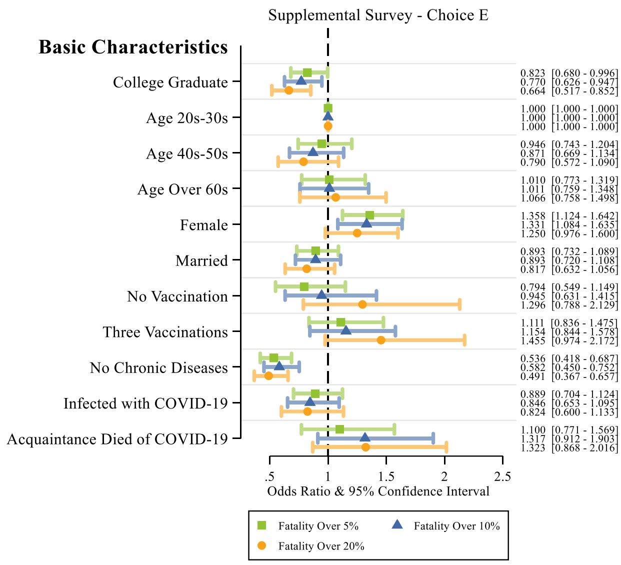


E. Group Choice E

a) Infection Risk



(b) Fatality Risk



N(Each group) = 2,002. In the regressions, we control for the media source and regional fixed effects.