Research Article

Evolution of Perceived Vulnerability to Infection in Japan During the COVID-19 Pandemic

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The global pandemic triggered by the emergence of the highly contagious disease known as COVID-19 has brought about substantial shifts in the everyday lives of individuals across the globe. The present study aimed to elucidate the evolution of perceived vulnerability to disease (PVD) before, during, and after the pandemic by comparing PVD levels in Japan from 2018 to 2023. The results showed that although PVD (consisting of perceived infectability and germ aversion) increased significantly in the early stages of the pandemic in 2020, it decreased each year thereafter. By 2023, perceived infectability had declined to a level lower than in 2018, while germ aversion, although lower than in 2020, remained higher than pre-pandemic levels. This finding indicates a tendency to underestimate one's resistance to infection during the pandemic, while after the crisis abated, individuals tend to assess their resistance to infection more positively. In contrast, germ aversion continued to show a lasting effect, remaining elevated even three years after the peak. These results suggest that the pandemic may have introduced a dual effect: in addition to heightening sensitivity to infection prevention, it may have cultivated a sense of "overconfidence" regarding infection resistance. This overconfidence potentially contributes to a more relaxed attitude toward infectious disease risks, as individuals perceive themselves as resilient after enduring an unprecedented public health crisis.

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Introduction

COVID-19 pandemic in Japan

Since the first case of COVID-19 was reported in December 2019, the virus has spread globally from 2020 onward, not only posing a significant threat to human life but also fundamentally altering daily behaviors. Practices such as the routine wearing of masks and frequent use of alcohol-based sanitizers have become markedly more common compared to the pre-COVID-19 period, as individuals grew increasingly aware of the risk of viral transmission in daily life. Beyond voluntary precautions, governmental directives and societal norms enforced certain behavioral adjustments. Notably, in May 2020, the Japanese government introduced a Practicing "New Lifestyle" aimed at COVID-19 pandemic mitigation[1]. This guidance emphasized: (1) Basic infection prevention measures for each person, such as "keep a distance of two meters as much as possible, or at least one meter, between two persons" and "wash your hands and face first when you get back home"; (2) Infection prevention related to traveling, including "Wash and sanitize hands frequently" and "Avoid gatherings in crowded places, close contact settings and closed spaces (three Cs)"; (3) Lifestyle for each scene of daily life (Shopping, Leisure, Sports etc., Public Transports, Meals, Family ceremonial occasions); and (4) New working styles, like remote work. These recommendations broadly reshaped everyday activities. Moreover, from 2020, government and corporate-supported research efforts intensified to encourage behaviors designed to prevent COVID-19 transmission[2]. Thus, during the pandemic, Japanese citizens were expected to comply with new behavioral norms advocated by the government and research institutions to support infection prevention in daily practices.

The Perceived Vulnerability to Disease

Infectious diseases pose a critical threat to humanity, comparable to disasters and famines[3]. Pandemics such as smallpox, plague, cholera, and Spanish flu have resulted in human losses on an unprecedented scale, surpassing even the tolls of the World Wars. The COVID-19 pandemic, too, spread across borders at a surprising rate due to globalization and modern infrastructure, leading to significant loss of life[4][5]. Throughout history, humanity has faced the threat of infectious diseases, which is believed to have led to the development of protection mechanisms against these threats through natural selection pressures[6].

doi.org/10.32388/4CO88Y

Humans cannot directly perceive viruses or germs, which are common causes of infectious diseases. Consequently, responses to pathogens are generally categorized into two types: expelling pathogens that have entered the body or engaging in behaviors that avoid pathogen exposure altogether. The former includes involuntary responses such as sneezing, coughing, and fever, all part of the immune system's response[7]. In contrast to these automatic responses, the latter involves conscious, proactive behaviors influenced by perceived information and susceptibility. Specific examples include infection prevention behaviors (such as wearing masks or using sanitizers) and responses of behavioral immune systems that avoid potential infection by exhibiting aversion to disease-related signals (Schaller, 2011).

Therefore, protecting oneself from threatening pathogens requires a recognition of one's vulnerability to infectious diseases. Measuring perceived vulnerability to infection necessitates assessing one's subjective sensitivity to both the physiological immune system and the behavioral immune system. The Perceived Vulnerability to Disease (PVD) Scale is a measure designed to assess this subjective susceptibility to infectious diseases (Duncan, Schaller, & Park, 2009). The PVD scale consists of two subscales: "perceived infectability," which assesses beliefs about one's own susceptibility to infectious diseases, and "germ aversion," which assesses emotional discomfort in contexts that connote an especially high potential for pathogen transmission (Duncan, Schaller, & Park, 2009). The perceived infectability subscale contains seven items, measuring self-perceived vulnerability in the biological immune system's ability, while the germ aversion subscale includes eight items, assessing the sensitivity in the behavioral immune system based on aversion.

The Effect of the COVID-19 Pandemic on PVD and Behavior

Studies have reported that higher levels of PVD during the COVID-19 pandemic increase engagement in infection-preventive behaviors[8]. In Japan, higher PVD levels have been associated with an increased frequency of mask-wearing[9]. Furthermore, even in post-pandemic, the continuation of behaviors promoted during the pandemic—such as mask-wearing, sanitizing, and maintaining physical distance—has been documented[10]. This suggests that sustained infection-prevention behaviors may have solidified an elevated state of PVD. Specifically, the widespread transmission and severe impacts of the COVID-19 pandemic likely led to a heightened sense of perceived infectability, which may have stabilized at an elevated sensitivity. Behavioral immunity develops through learned experiences; thus, repeated engagement in preventive behaviors can lead to acquired aversions to certain stimuli (Rozin et al., 2008). Consequently, avoiding aerosol-transmitting behaviors such as sneezing and coughing by others, and even avoiding crowded places over a prolonged period, may have increased germ aversion and solidified at an elevated sensitivity.

Method

In this experiment, data from a Japanese version of the Perceived Vulnerability to Disease scale[11] collected in 2018, 2020, 2021, 2022, and 2023 were analyzed. Perceived infectability and germ aversion subscale scores were treated as dependent variables and compared using a one-way analysis of variance (ANOVA). The scale scores were the average of the responses to the subscale items. Additionally, to test for differences between survey years, multiple comparisons were performed using the Tukey-Kramer method. Data from 2018, 2020, and 2021 were obtained from publicly available datasets collected for purposes other than this study. The data collection periods were September 2018[12], June 2020[2], and January 2021[13]. In addition, for this study, online surveys were conducted on March 19, 2022, and March 20, 2023, to collect responses to the PVD scale.

Participants were recruited through Yahoo! Crowdsourcing, and responses were collected via Google Forms. In the 2022 survey, a total of 2,176 individuals participated (mean age = 50.78 years; 1,372 men, 772 women, 31 others). Data from 17 participants who incorrectly answered an attention check calculation question were excluded. In the 2023 survey, 2,074 individuals participated (mean age = 50.78 years; 1,337 men, 724 women, 13 other), with 40 participants excluded for incorrect answers to the attention check question, leaving 2,034 for analysis. Using these procedures, PVD scores from a total of five years were compared.

Results

Figure 1 shows the main results. A one-way ANOVA was conducted using the perceived infectability subscale scores as the dependent variable, and the main effect of survey year was found to be significant ($F(4, 9822) = 41.804$, $p < .001$, $\eta^2 = .017$). The descriptive statistics were as follows: 2018 ($N = 1382$, $M = 3.83$, $SD = 1.14$), 2020 ($N = 1304$, $M = 4.06$, $SD = 1.19$), 2021 ($N = 1943$, $M = 3.86$, $SD = 1.09$), 2022 ($N = 2159$, $M = 3.86$, $SD = 1.09$), and 2023 ($N = 2034$, $M = 3.60$, $SD = 1.10$). Post hoc multiple comparisons indicated that perceived infectability in 2020, at the onset of the COVID-19 pandemic, was significantly higher than in 2018, 2021, 2022, and 2023 (2018 vs. 2020: $t(9822) = -5.542$, $p < .001$, $d = -0.214$; 2020 vs. 2021: $t(9822) = 3.93$, $p < .001$, $d = 0.1307$; 2020 vs. 2022: $t(9822) = 5.257$, $p < .001$, $d = 0.1844$; 2020 vs. 2023: $t(9822) = 11.894$, $p < .001$, $d = 0.4219$). There was no significant difference in perceived infectability between 2018 and the post-pandemic years of 2021 and 2022 (*p*s >.01). Notably, perceived infectability in 2023 was significantly lower than in 2018, 2020, 2021, and 2022 (2018 vs. 2023: $t(9822) = 5.966$, $p < .001$, $d = 0.2080$; 2021 vs. 2023: $t(9822) = 10.103$, $p < .001$, $d = 0.2912$; 2022 vs. 2023: $t(9822) = 7.688$, $p < .001$, $d = 0.2376$).

For the germ aversion subscale scores, a one-way ANOVA also revealed a significant main effect of survey year ($F(4, 9822) = 149.17$, $p < .001$, $\eta^2 = .057$). The descriptive statistics were as follows: 2018 ($M = 4.33$, $SD = 0.98$), 2020 ($M = 5.10$, $SD = 1.06$), 2021 ($M = 4.68$, $SD = 1.00$), and 2023 ($M = 4.70$, $SD = 1.14$). Post hoc multiple comparisons indicated that germ aversion in all survey years following 2018 was significantly higher than in 2018 (2018 vs. 2020: $t(9822) = -19.81$, $p < .001$, $d = -0.765$; 2018 vs. 2021: $t(9822) = -20.768$, $p < .001$, $d = -0.677$; 2018 vs. 2022: $t(9822) = -9.822$, $p < .001$, $d = -0.3384$; 2018 vs. 2023: $t(9822) = -10.226$, $p < .001$, $d = -0.3565$). No significant decrease in germ aversion was found between 2020 and 2021 ($p = .145$), but germ aversion in 2022 and 2023 was significantly lower than in 2020 (2020 vs. 2022: $t(9822) = 11.839$, $p < .001$, $d = 0.4152$; 2020 vs. 2023: $t(9822) = 11.193$, $p < .001$, $d = 0.3971$).

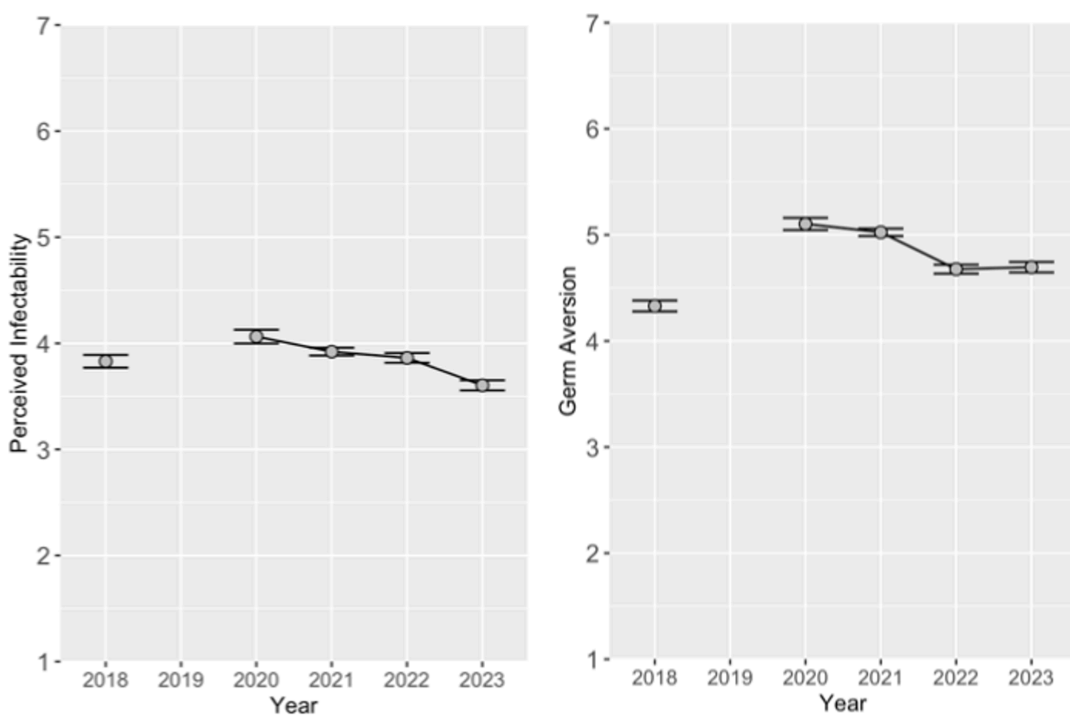

Figure 1. Mean scores of PVD subscales by year. The error bars denote 95% confidence intervals. Left: Results for the perceived infectability subscale. Right: Results for the germ aversion subscale.

doi.org/10.32388/4CO88Y

Discussion

In this study, we hypothesized that the COVID-19 pandemic would lead to an elevated PVD and that this heightened level would be maintained in the post-pandemic period. The results of the one-way ANOVA and post hoc comparisons indicated a significant increase in both perceived infectability and germ aversion in 2020 compared to pre-pandemic levels in 2018, supporting the prediction that the pandemic would elevate PVD. These findings suggest that the COVID-19 pandemic affected PVD. However, a significant year-over-year decline from 2020 was observed for both perceived infectability and germ aversion. This suggests that, even with a global pandemic, PVD may not establish irreversibly elevated levels within the population. This result contrasts with reports of continued voluntary infection-prevention behaviors post-pandemic. Nonetheless, it has been suggested that the continuation of behaviors such as mask-wearing, even after government recommendations ceased, may be influenced by social considerations, where individuals maintain preventive measures due to concern about others' evaluations[14]. There may be a higher-than-expected proportion of individuals who, despite perceiving themselves as resilient to infectious diseases, continue preventive behaviors due to concerns about how they are perceived by others.

Focusing on perceived infectability, although it initially increased in June 2020, by March 2022, it had returned to a level not significantly different from pre-COVID-19 levels. In Japan, the last state of emergency for COVID-19 was declared in September 2021, and 2022 marked the period when daily life and behaviors gradually began to revert to pre-pandemic norms. This return to normalcy may have contributed to the decrease in perceived infectability to pre-COVID-19 levels. Additionally, the decrease in perceived infectability may be influenced by the increase in vaccination rates. While COVID-19 vaccines were still in clinical trials in June 2020, vaccinations began in February 2021 (Cabinet Public Affairs Office, Cabinet Secretariat, 2021), and by March 2022, many individuals had already received their third booster dose. Thus, the perception that one's body had become more resistant to infectious diseases due to vaccination may have contributed to the decrease in perceived infectability, warranting further examination of this point.

The most unusual result was the significant decrease in perceived infectability in March 2023, where it was even lower than pre-pandemic levels. Results of multiple comparisons for 2023 and other years indicated that perceived infectability did not simply revert to pre-pandemic levels after the turmoil of the pandemic but instead suggested an increased self-assessment of resilience to infectious diseases compared to before the pandemic. This may be attributed to factors such as multiple vaccine doses and a comparison of one's own symptoms with those of severe cases, leading individuals to view themselves as having a body resilient enough to survive the pandemic. It is currently unclear whether this decrease in perceived infectability is temporary or sustained. Therefore, continuous surveys are necessary to monitor this trend in the future.

Focusing on germ aversion, its trends from 2018 to 2022 were similar to those of perceived infectability, showing an increase in 2020 followed by a gradual decline in subsequent years. This decrease may also suggest that vaccination contributed to a reduced aversion to behaviors associated with the risk of droplet infection. However, the trend in 2023 differs from that of perceived infectability. Results of multiple comparisons indicated that, although germ aversion significantly decreased from 2020, it remained significantly higher than in 2018. This suggests that aversion based on the behavioral immune system, may be more susceptible to prolonged influence from threats of pandemics than self-assessments of biological immunity. These findings reveal that even after experiencing a pandemic that drastically altered lifestyles, peak sensitivity gradually declines over time. However, the fact that germ aversion remained significantly higher than pre-COVID-19 levels in 2018 suggests that lifestyle changes and heightened awareness of viral threats have maintained a certain level of aversion.

While peak levels of sensitivity were not sustained, it was evident that aversion to infection-related behaviors remained stronger than pre-pandemic levels over a period of several years. Additionally, the pandemic appears to have introduced a dual effect: beyond increasing sensitivity to infection prevention, it may have fostered a sense of "overconfidence" in infection resistance, potentially leading to a more relaxed stance towards infectious disease risks, given that people perceive themselves as resilient for having survived an unprecedented crisis. Moving forward, it is essential to continue research on PVD while also comparing it with available international data to explore the underlying causes of sensitivity changes induced by the pandemic.

Statements and Declaration

Funding Information

This research was supported by JSPS KAKENHI grant nos.JP20J21976 (A.I.). JP23K11278 (K.S.), JP23H01057 (K.S.), JP22K13881 (K.S.), JP21H03784 (K.S. and Y.Y.), and JP22K18263 (Y.Y.). The funders had no role in study design, data collection, analysis, decision to publish or preparation of the manuscript.

Conflict of interests

No potential competing interests to declare.

Authors' contributions

All authors contributed equally to the writing of this manuscript.

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Declarations

Funding: This research was supported by JSPS KAKENHI grant nos.JP20J21976 (A.I.). JP23K11278 (K.S.), JP23H01057 (K.S.), JP22K13881 (K.S.), JP21H03784 (K.S. and Y.Y.), and JP22K18263 (Y.Y.). The funders had no role in study design, data collection, analysis, decision to publish or preparation of the manuscript.

Potential competing interests: No potential competing interests to declare.