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Final Research Report: The Hitachi Fund Support for Research Related to Infectious Diseases

Digital Edition

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The Hitachi Global Foundation

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Foreword

Hidenobu Nakahata
President
The Hitachi Global Foundation

I would like to express my sincere gratitude for your continued and generous support for the operation of The Hitachi Global Foundation.

On the occasion of publishing this final research report of the Fund, I would like to offer a few words of greeting.

The Hitachi Global Foundation has its roots in five foundations established since 1967 by the vision and dedication of successive management leaders of Hitachi, Ltd. Following the integration of these five foundations in April 2015, we have inherited the passionate aspirations and principles of their founders. Centering our activities on "Promotion of Academic Research, Science and Technology," "Human Development" and "Realization of an Inclusive Society," we leverage the extensive experience and knowhow accumulated within the Hitachi Group to respond to societal needs.

The emergence of the COVID-19 pandemic five years ago brought numerous social challenges to the forefront—challenges still fresh in your memory. Our effortless daily routines were abruptly disrupted, segmented, and isolated. Schools, workplaces, and even local communities were exposed to this unprecedented threat. The spread of COVID-19 imposed various socioeconomic restrictions on people, compelling them to live differently and profoundly impacting society. Moreover, the repeated outbreaks of variants and the prolonged nature of the pandemic have significantly influenced people's thoughts and behaviors. New lifestyles and behavioral norms, including unfamiliar terms like the "Three Cs" (closed spaces, crowded places, and close-contact settings), "social distancing," and even "self-restraint police," often accompanied by satire, as well as novel communication methods utilizing online platforms, have given rise to new values and ways of living.

This Fund, established in 2021 through donations from Hitachi, Ltd., its executives, employees, and group company executives, supports research activities over a three-year period. The research aims to broaden the scope beyond COVID-19 to infectious diseases in general and to academically investigate, analyze, and consider social issues arising during infectious disease outbreaks based on evidence, sharing the findings internationally. We deeply appreciate all those who generously contributed to the founding of this Fund.

The call for research proposals began in April 2021, and following review by the selection committee, five research projects were selected in November of the same year. Research activities commenced in December.

To share the knowledge gained during the three-year research period on an international scale, an international symposium was held on February 26, 2025, at the Keidanren Kaikan in Chiyoda-ku, Tokyo, where representatives of each project presented their findings.

Although COVID-19 was reclassified to Category 5 infectious disease in May 2023, influenza outbreaks have surged since the end of 2024, followed by a rise of whooping cough. The battle against infectious diseases remains unpredictable. Various other infectious diseases are also spreading overseas, continuing to threaten everyday life worldwide.

This report presents intriguing research outcomes achieved through diverse approaches and analyses by each project. To ensure this is not merely a transient report, I earnestly hope that it will be read by many, and that it will serve as a valuable resource for years to come. I truly wish that these research achievements serve as a catalyst toward building a more resilient and robust society. With these words, I conclude this message.

Report on Grant-Related Events

This chapter provides an overview of the events conducted under the “Hitachi Fund Support for Research Related to Infectious Diseases”.

Since December 2021, the fund has supported five research projects related to infectious diseases over a period of three years. After the grant decisions, a research summary presentation was held, followed by two interim report meetings to share updates on the research. Furthermore, an international symposium was organized as an opportunity to widely disseminate the research outcomes.

1. Presentation of Research Summary

Date & Time: Wednesday, January 12, 2022, 14:00–15:20

Format: Online (Zoom Webinar)

Participants: Principal researchers, joint researchers, selection committee members, executives of Hitachi, Ltd. and Hitachi Group companies, and general public (68 participants)

Agenda:

- 14:00: Opening remarks by the President of The Hitachi Global Foundation
- 14:05: Comments by Chairperson of Selection Committee
- 14:15: Presentation of Research Summary (five selected research projects)
- 15:15: Closing Remarks

Event Report: https://www.hitachi-zaidan.org/global/topics/topics004.html

2. First Interim Report Meeting

Date & Time: Tuesday, March 7, 2023, 17:00–19:30

Format: Hybrid (In-person and Zoom Webinar)

Venue: The Industry Club of Japan Hall

Online: Zoom Webinar

Participants: Principal researchers, joint researchers, selection committee members, and executives of Hitachi, Ltd., and Hitachi Group companies
Closed event (18 participants on-site, 4 online)

Agenda:

- 17:00: Opening remarks by the President of The Hitachi Global Foundation
- 17:05: First Interim Report on Five Research Projects
- 19:20: Comments by Chairperson of Selection Committee
- 19:30: Closing

Event Report: https://www.hitachi-zaidan.org/global/topics/topics010.html

3. Second Interim Report Meeting

Date & Time: Wednesday, March 13, 2024, 17:00–20:00

Format: Hybrid (In-person and Zoom Webinar)

Venue: AP Tokyo Marunouchi

Online: Zoom Webinar

Participants: Principal researchers, joint researchers, selection committee members, and executives of Hitachi, Ltd., and Hitachi Group companies
Closed event (20 participants on-site, 5 online)

Agenda:

- 17:00: Opening remarks by the President of The Hitachi Global Foundation
- 17:05: Second Interim Report on Five Research Projects

19:45: Comments from the Chairperson of the Selection Committee
20:00: Closing
Event Report: https://www.hitachi-zaidan.org/global/topics/topics013.html

4. International Symposium on “Hitachi Fund Support for Research Related to Infectious Diseases” – Initiatives and Insights Learned in Infectious Disease Control from the COVID-19 Pandemic Experience –.

Date & Time: Wednesday, February 26, 2025, 16:00–19:05 (JST)
Format: Hybrid (In-person and Zoom Webinar)
Venue: Keidanren Kaikan Conference, 4th Floor “Diamond Room”
Online: Zoom Webinar
Languages: Japanese & English (Simultaneous interpretation provided)
Participants: Principal researchers, joint researchers, selection committee members, executives of Hitachi, Ltd. and Hitachi Group companies, and general public (53 on-site, 184 online)
Agenda:
16:00: Opening remarks by the President of The Hitachi Global Foundation
16:10: Research Presentation and Q&A Session on Five Research Projects
18:50: Comments from the Chairperson of the Selection Committee
19:05: Closing
Event Report: https://www.hitachi-zaidan.org/global/activities/fundsupport/topics/2503001.html

Scene from the International Symposium venue

Commemorative Photo of the International Symposium

International Joint Study on Public Health Economics and Value Assessment of Prevention in Pandemic — Lessons Learned from COVID-19 and Evidence-Based Recommendations for Future Crisis

Grant Period: from December 1, 2021 through November 30, 2024
Grant Amount: 50 million yen
Principal Researcher: Hiroshi Suzuki (from April, 2023)*
Professor, Graduate School of Public Policy, The University of Tokyo
*Former principal researcher: Akio Onishi (from December, 2021 through March, 2023)
Visiting Professor, Graduate School of Public Policy, The University of Tokyo

This study divided into groups from Europe, North America, and Asia, examined the lessons learned from the COVID-19 pandemic, focusing on public health economics that evaluates the balance between healthcare and economy, the effectiveness and value of vaccination, and diagnostic testing aimed at active epidemiological investigations and infection containment. As a result, based on the various multivariable infection control models constructed, it was quantitatively clarified that measures such as population movement restrictions and large-scale PCR testing implemented by authorities, as well as vaccination, were not as effective as initially expected at the onset of the pandemic, and further explored why that was the case, including the extent of cost-effectiveness. Based on the findings, specific recommendations were made to confront the upcoming 'Pandemic X'.

Co-investigators (*: Group Leader)
○Europe group:
- Ulf Persson*, Professor of Health Economics, Senior Advisor, The Swedish Institute for Health Economics, Sweden
- Gunnar Brådvik, Research Analyst,The Swedish Institute for Health Economics, Sweden
- Jörgen Möller, Vice President, Modeling Technologies at Evidera, Sweden
- Pierre-Yves Geoffard, Professor of Economics, Paris School of Economics, France

○North America group:
- J. Jaime Caro*, Professor of Medicine, Epidemiology and Biostatistics, McGill U, Canada; Professor in practice, Health Policy, LSE, London UK, Chief Scientist, Evidera, Boston MA, USA

○Asia group:
- Isao Kamae*, Project Professor, Graduate School of Public Policy, The University of Tokyo
- Makoto Kobayashi, Chief Operating Officer, Crecon Medical Assessment Ltd.
- Ryo Watanabe, Associate Professor, Kanagawa University of Human Services
- Chee Jen Chang, Distinguished Professor, Chang Gung University, Taiwan
- Hwee-Lin Wee, Associate Professor, National University of Singapore, Singapore
  (Other members of the research team in Singapore: Celestine Cai, Sharon Tan, Borame Dickens, Nigel Lim)
- Jeonghoon Ahn, Professor, Ewha Womans University, South Korea

1. Research Objectives

In recent years, the COVID-19 pandemic has had a significant impact on the world, resulting in a great loss of life, and the international community has experienced a healthcare and economic dilemma on an unprecedented scale. This research uses the COVID-19

pandemic as a case study to examine its lessons, deepen academic knowledge for future pandemic measures, and pursue 'value-based' solutions to the healthcare and economic dilemma. The goal of this research is to enhance the international community's preparedness for the upcoming 'Pandemic X' under a 'With Corona' framework and contribute to the achievement of global health.

2. Research Methods and Progress

The research group adopted a structure where it was divided into three groups: Europe, North America, and Asia, each working on their respective sub-themes. Specifically, the European group focused on preventive intervention I (public health economics) and analyzed the balance between healthcare and the economy observed during urban lockdowns. The Asian group concentrated on preventive intervention II (evidence-based testing strategies) and examined whether infection containment was possible through active epidemiological investigations and testing strategies. The North American group reviewed the evaluation of the value of vaccines for society and individuals under preventive intervention III (the impact of vaccination). Each group independently held internal research meetings and, as needed, organized online plenary meetings to communicate the progress and research outcomes between the groups.

The research period lasted for three years, so annual objectives were set for each year. Specifically, in the first year, COVID-19 was reviewed for three groups: Asia, North America, and Europe, and research design and data collection were carried out. In the second year, analyses were conducted for each group, and in the third year, comprehensive recommendations were compiled based on the results of the group-specific studies, and a final report was produced.

The proceedings of the general meetings held are as follows:

- 1st meeting: April 5, 2022
- 2nd meeting: June 9, 2022
- 3rd meeting: September 12, 2022
- 4th meeting: December 21, 2022, at the University of Tokyo International HTA Symposium, Part 2 "International Collaborative Research Report on the COVID-19 Pandemic"
- 1st Hitachi Foundation interim report meeting: March 7, 2023
- 5th meeting: October 25, 2023
- 6th meeting: December 8, 2023, at the University of Tokyo International HTA Symposium "Lessons from the COVID-19 Pandemic - An Approach to Value Assessment"
- 2nd Hitachi Foundation interim report meeting: March 13, 2024
- 7th meeting: September 24, 2024
- 8th meeting: November 1, 2024, at the University of Tokyo International HTA Symposium "Lessons from COVID-19 - The Past and Future"
- Hitachi Foundation International Symposium (Final Report Meeting): February 26, 2025

In addition to the above general meetings, each team held local meetings independently. A project-specific database was also created on Google Drive for information sharing among members.

3. Research Achievements

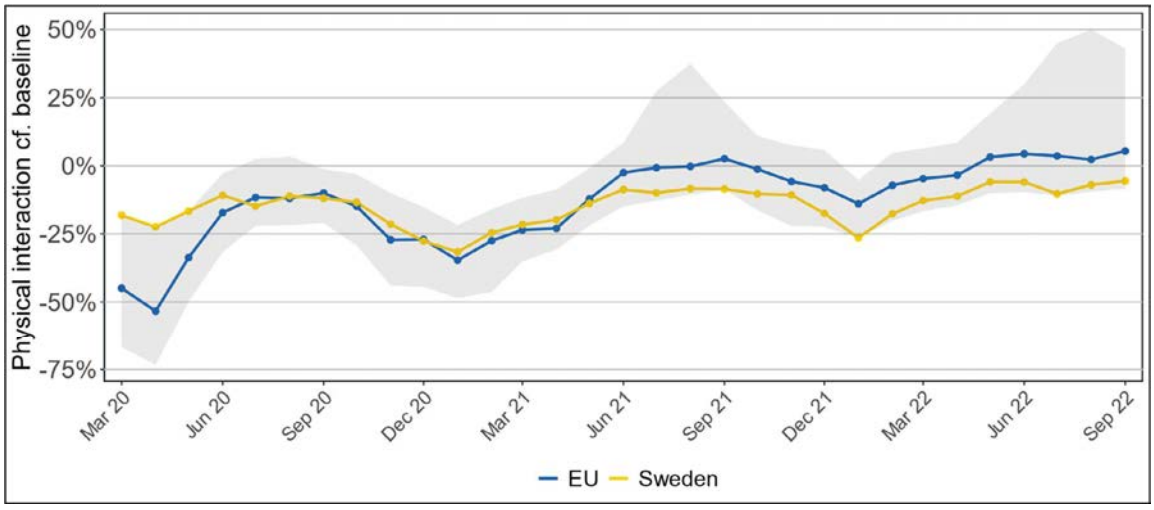
A literature review related to the sub-themes of each group for COVID-19 was conducted separately for each group, and the obtained literature information (Asia[1-25], Europe[26-61], North America[62-70]) was shared among all groups.

○Europe group

The European Group primarily focused on Sweden and France. First, Sweden's policy responses were based on voluntary measures and recommendations rather than legally imposed restrictions. Sweden implemented lockdown measures that completely or partially closed down economic sectors (which were looser than the EU average), while most of society remained open. As a result, Sweden faced severe criticism for its generous and liberal approach during the pandemic. Initially, mobility was higher than the EU average, but by the summer of 2020, it aligned with the EU average, and after spring 2021, it was actually lower than the EU average (Figure 1).

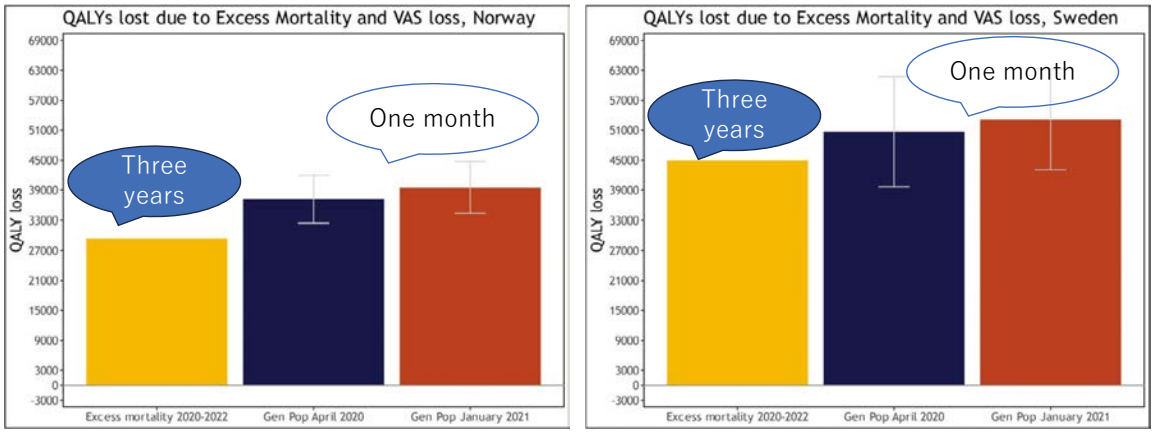
Norway and Sweden had the two lowest excess mortality rates in Europe. Based on a medical economic analysis model from the European group, it was estimated that, as shown in Figure 2, the QALY (Qual-

Source) Ulf Persson



Baseline: January-February 2020

Figure 1. Physical interaction in Sweden and EU average, 11th March 2020 – 14th September 2022



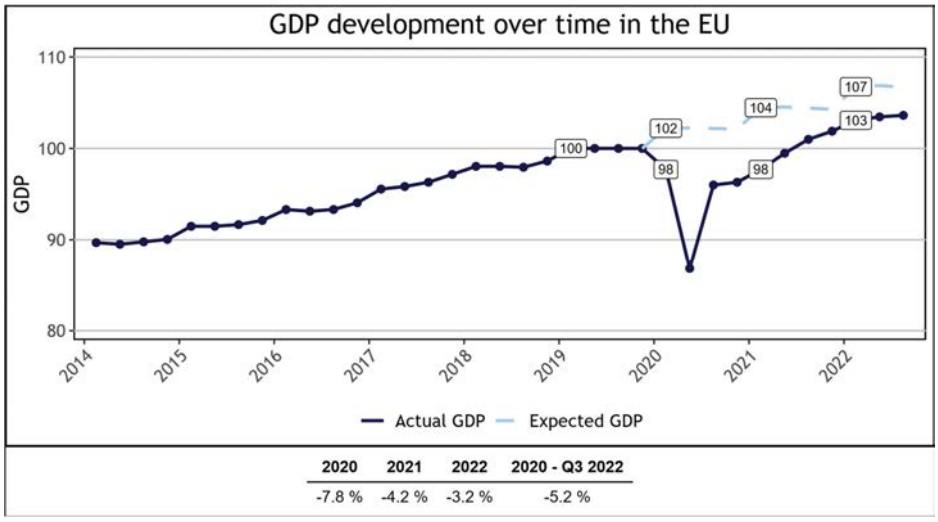
Source) Ulf Persson

Figure 2. QALYs lost due to excess mortality for all three years 2020-2022 and QALY loss for general population in April 2020 and January 2021, two months with high physical restriction and reduced geographical mobility, in Norway and Sweden.

ity-Adjusted Life Years) loss due to excess mortality in both countries over the three years from 2020 to 2022 was less than the QALY loss for the entire population in April 2020, when movement restrictions were strict, or in January 2021 for one month. This suggests that the strict movement restrictions in the first year of the pandemic were not necessarily effective in preventing QALY losses for people.

French society was inadequately prepared for the pandemic. Specifically, during the early stages of the pandemic in the spring of 2020, masks and testing were unavailable. A lockdown at the EU average level was implemented in France, but despite the stay-at-home orders, schools remained open. The French government spent enormous subsidies as a substitute for income due to temporary unemployment and business downturns, with the budget reaching 200 billion euros (9% of GDP). Vaccination was rolled out under the coordination of the EU. Although the decline in GDP in France, which implemented a lockdown at the EU average level, was somewhat greater than the EU average (Figure 3), the recovery speed was nearly the same

Source） P-Y Geoffard



Considering the average growth rate during 2015 - 2019, the economic was smaller in 2022 than it would have been without the covid related decline in 2020. In that sense, the economy did not recover in 2022.

Figure 3. GDP change in EU

Source） P-Y Geoffard

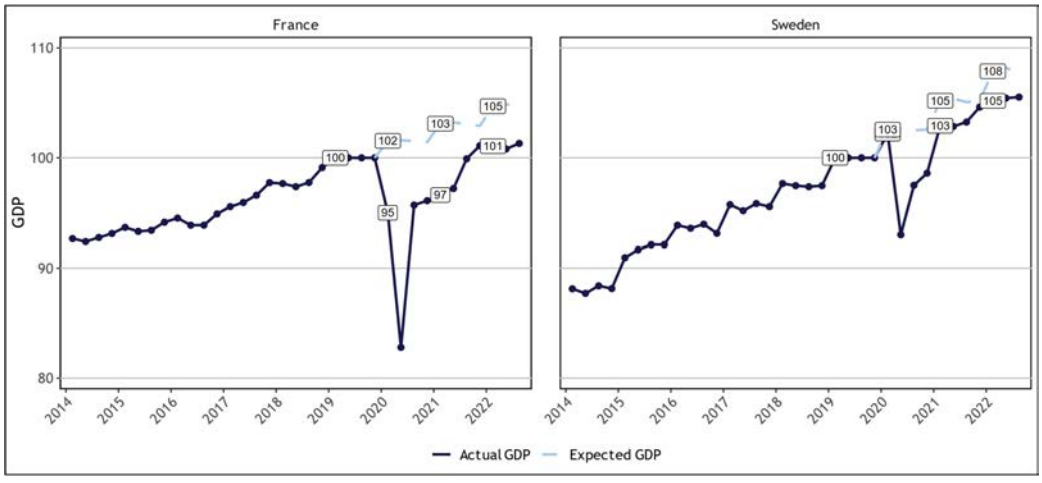


Figure 4. Actual vs. expected GDP growth in France and Sweden (based on the average 2015 – 2019)

(Figure 4). On the other hand, as shown in Figure 4, the decline in GDP in Sweden, which adopted a more lenient lockdown policy, was smaller compared to the EU average, and the recovery speed was faster. Figure 5 shows the relationship between excess mortality rates in EU countries from 2015 to 2019 and GDP losses from 2020 to 2022, indicating that while Sweden had lower excess mortality and GDP losses, France was almost average among EU countries, but had higher excess mortality and GDP losses compared to Sweden. Therefore, from the perspective of balancing medicine and the economy, Sweden's lenient lockdown policy yielded better results than France's.

In conclusion, the results obtained by the European group that took a health economics analytical approach can be summarized as follows:

- The behavior of individuals was largely explained by three variables that provide information about the risk of disease (excess mortality rate, ambient temperature, vaccination). There was a tendency for more

Source）P-Y Geoffard

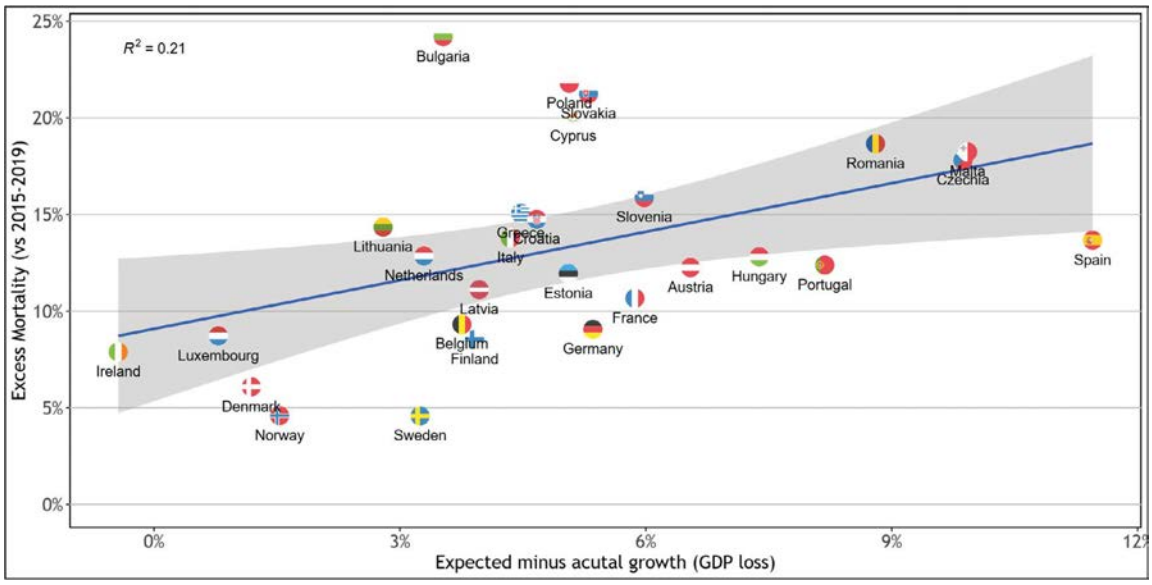


Figure 5. Excess mortality (y) and GDP loss (x) 2020 – 2022
all countries (EU + Norway)

people to avoid visiting crowded places as the number of deaths increased and the cold intensified.

- When the risk of disease decreased, the flow of people recovered faster than the easing of non-pharmaceutical interventions (NPI) such as lockdowns.

- Considering that NPIs were correlated with the three risk variables, NPIs themselves did not become significant factors in the flow of people and were not effective measures for reducing mortality rates.

- The duration since the start of the pandemic was identified as a fourth explanatory variable reflecting the costs of restricted social activities (loss of income, loss of education, loss of quality of life, etc.).

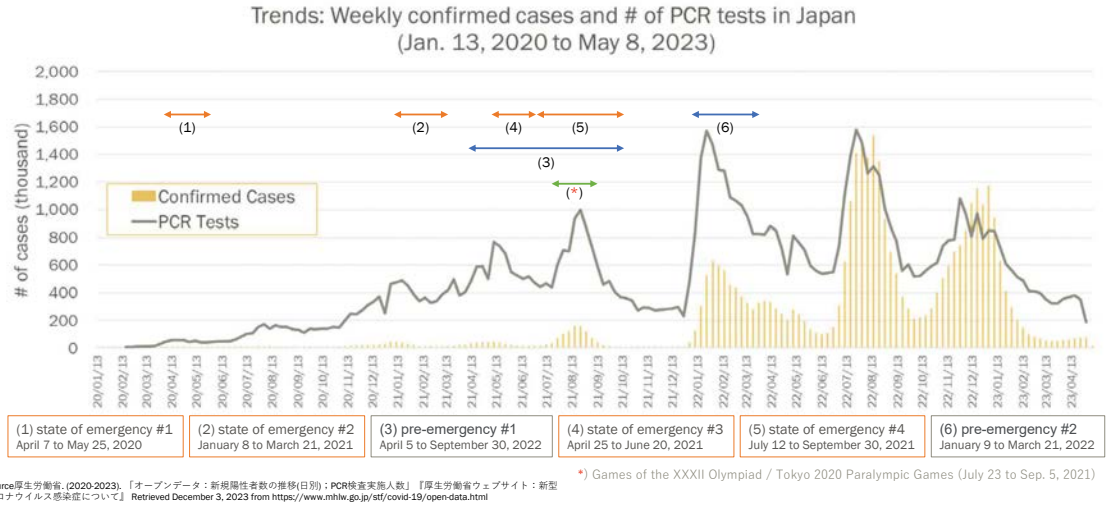
- Individuals recognized the balance between the risk of disease and their own costs due to restricted social interactions in making their behavioral choices.

- Macroeconomic activity was closely related to individuals' actual behaviors (a 10% reduction in physical activity resulted in a 2% decrease in the country's GDP).

○Asia group

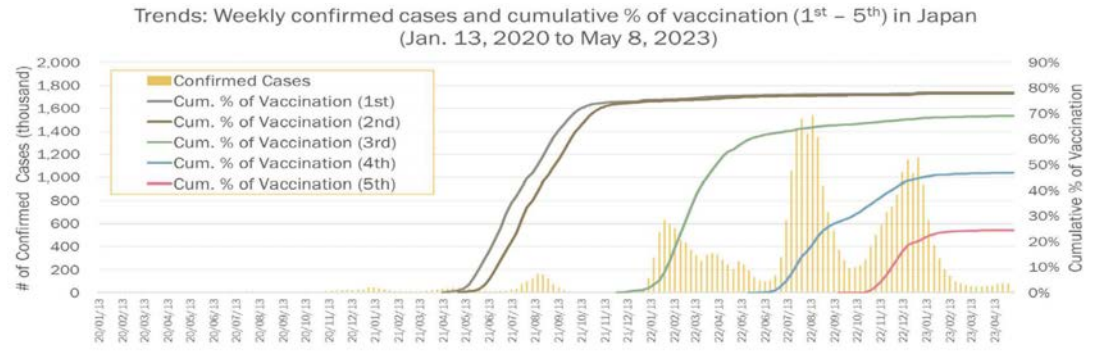
The number of COVID-19 cases in Japan was lower than in Europe and America[1]. However, like other countries, from 2020 to 2023, despite the implementation of testing and vaccinations, waves of infection repeated. In this context, a Japanese group focused on the technology assessment of PCR testing. This is because, unlike in Western countries, in Japan, restrictions on movement, such as lockdowns, were not legally imposed mandatory measures, but were implemented as a policy that respects the public's voluntary judgment called 'requests.' Therefore, containment of the virus through tracking of infected individuals and potential infections via PCR testing was emphasized.

However, in the early stages of the pandemic, the inadequacy of testing systems was criticized. A debate arose over whether administrative testing, which tracks infected individuals and potential carriers, was sufficient to control the pandemic, or if large-scale screening tests should be conducted across entire regions. This debate even escalated to a discussion about whether to prioritize healthcare or the economy. However, such discussions were also lacking in sufficient scientific analysis based on evidence. As shown in Figure 6, in Japan during the early to mid-infection stages of 2020-2021, administrative testing yielded certain results, making it appear as though infection control was functioning. However, after 2022, the explosive increase in the number of infections outpaced the PCR testing system, and ultimately, Japan's administrative testing system fell into dysfunction. As shown in Figure 7, the vaccination rate of the vaccine, which began administration in April 2021, initially



Source厚生労働省. (2020-2023).「オープンデータ：新規陽性者数の推移(日別)：PCR検査実施人数」『厚生労働省ウェブサイト：新型コロナウイルス感染症について』 Retrieved December 3, 2023 from https://www.mhlw.go.jp/stf/covid-19/open-data.html

Figure 6. Trends in COVID-19 cases and PCR test in Japan



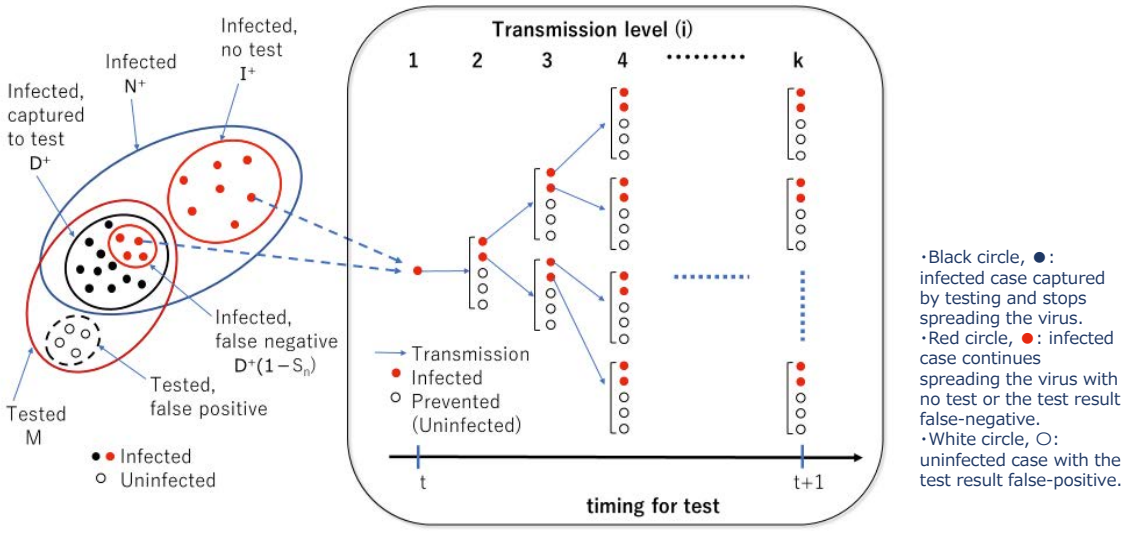
●The relation between testing strategy and vaccination is not well understood due to the multiple factors that determine the effectiveness of the vaccine.

Source 厚生労働省. (2020-2023).「オープンデータ：新規陽性者数の推移(日別)：死亡者数（累積）」『厚生労働省ウェブサイト：新型コロナウイルス感染症について』 Retrieved December 3, 2023 from https://www.mhlw.go.jp/stf/covid-19/open-data.html
デジタル庁. (2023).「新型コロナワクチンの接種状況」『デジタル庁：ワクチン接種記録システム（VRS)』 Retrieved December 3, 2023 from https://info.vrs.digital.go.jp/dashboard/
総務省. (2020-2023).「【総計】都道府県別年齢階級別人口」『住民基本台帳に基づく人口、人口動態及び世帯数調査』 Retrieved December 3, 2023 from https://www.e-stat.go.jp/stat-search/files?page=1&toukei=00200241&tstat=000001039591

Figure 7. Covid-19 past in Japan: Vaccination

reached around 80%, but declined with each subsequent (third, fourth, fifth) wave, as significant surges in infections repeatedly occurred. Such trends were thought to result from various factors, including the mutable mutations of the virus, disappointing expectations of vaccine effectiveness in preventing infections (it was assessed that they only had effectiveness in preventing severe cases), and the spread of anti-vaccine campaigns fueled by conspiracy theories.

Therefore, the Japan team decided to establish and analyze a new analytical model to evaluate the effectiveness and cost-effectiveness based on the Japanese administrative testing strategy that tracks infected and potentially infected individuals. Figure 8 illustrates this analytical model. Specifically, let M people be tested through administrative tracking, among which D^+ are infected individuals. Among those M people, there may be individuals who test positive despite not being infected (false positives), but since they would be subject to isolation, they are considered irrelevant for the analysis in terms of infection transmission. The concern from an infection transmission perspective is the presence of individuals who are infected but test negative (false negatives). Let Sn denote the sensitivity of the PCR test (the probability that an infected person tests positive), which implies that $D^+(1\text{-}Sn)$ people would be false negatives. Assuming that there are I^+ individuals among the population being tracked who are infected



出典）Kamae I. A Theory of Diagnostic Testing to Stop the Virus Spreading: Evidence-based Reasoning to Resolve the COVID-19 Crisis by Testing. The Keio Journal of Medicine 71(1):pp.13-20, 2022. DOI: 10.2302/kjm.2021-0009-IR [8]

Figure 8. Cascade model of testing and transmission in infection

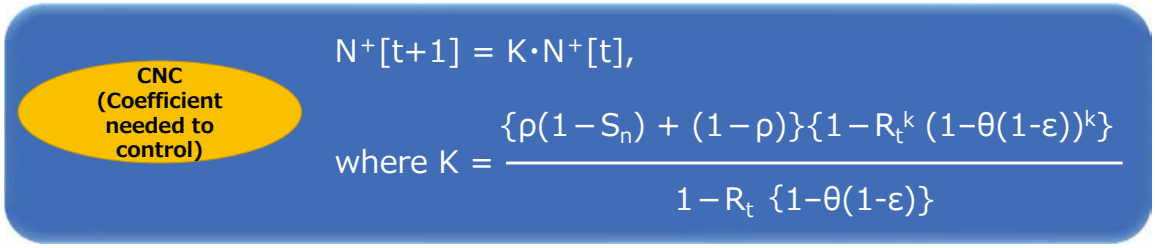
Table 1. Model parameters

The Cascade model of testing and transmission in infection developed with the factors:
●virulence of a virus: **k**, level of transmission, **Rt**, effective reproduction number,
●Immunity: **θ**, immunity protection rate in individuals, **ε**, evasion rate of virus from vaccines or immunity protection,
●Diagnostic accuracy: **Sn**, test sensitivity,
●Target population and cases: **M**, the number of cases tested, **D⁺**, the number of infected cases in M, **N⁺**, the number of all the infected cases in a target population needed to be tested and traced at time t, **I⁺**, the number of infected cases, left being not tested in the target population, and **ρ**, capture rate of infected cases (where $I^+ = D^+(1-\rho)/\rho$) because of $\rho = D^+/(D^+ + I^+)$.

but were not included in the testing target, the total number of potential infected individuals that would circumvent administrative testing and spread the infection to others would be $D^+(1\text{-}Sn) + I^+$.

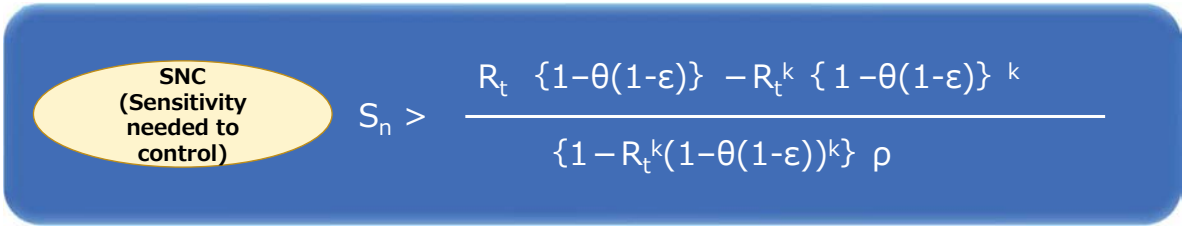
The right half of the cascade diagram in Figure 8 models the possibility that an infected individual who has passed such inspections spreads the infection up to level k between time point t and time point t+1 (the testing day and the next testing day, usually the following day). It is assumed that whether or not he/she becomes infected varies based on parameters such as the effective reproduction number Rt (the number of people that one infected person actually infects), the rate θ at which individuals can prevent infection, and the viral immune evasion rate ε. Additionally, among the total number of infected individuals $D^+ + I^+$ in the target population to be tracked, the number of infected individuals that can be captured as test positive is defined as D^+, so the infection capture rate is defined as ρ ($= D^+/(D^+ + I^+)$).

Under this analytical model, Figure 9 shows the relationship between the number of infected individuals $N^+[t]$ at time t and $N^+[t+1]$ at the next time point t+1. $N^+[t]$ and $N^+[t+1]$ are linked by the coefficient K (called the coefficient needed to control, CNC), which is formulated as a function of the sensitivity of PCR testing Sn, the level of infection spread k, the effective reproduction number Rt, the rate at which individuals can prevent infection θ, the virus's immune evasion rate ε, and the rate at which infections are captured ρ.



出典）Kamae I: How did The Analysis of Dynamic Processes of Virus Transmission: How Could Diagnostic Tests and Vaccinations Stop COVID-19 Pandemic? Research Poster EPH65, ISPOR 2023, Boston, USA, May 8, 2023.

Figure 9. The formula for change of infected cases over time
K: Coefficient needed to control. If K < 1, infection can be stopped.



出典）Kamae I: How did The Analysis of Dynamic Processes of Virus Transmission: How Could Diagnostic Tests and Vaccinations Stop COVID-19 Pandemic? Research Poster EPH65, ISPOR 2023, Boston, USA, May 8, 2023.

Figure 10. Test sensitivity needed to control
- The SNC (sensitivity needed to control) is a new term for the minimal test sensitivity that can converge the virus spread.
- The SNC is derived from developing the following inequation of K for Sn:
  $K = \{\rho(1-Sn) + (1-\rho)\}\{1-R_t^k\,(1-\theta(1-\varepsilon))k\} / \{1-Rt\,(1-\theta(1-\varepsilon))\} < 1$.

Table 2. Example of the SNC: the simplest case
- Rt: effective reproduction number, k: level of transmission
- Cell areas: White(Sn < 0.7), Gray (0.7 < Sn < 0.95), Black (0.95 < Sn)

Rt \ k	2	3	4	5	6
1.5	0.6	0.7895	0.8769	0.9242	0.9519
2	0.6667	0.8571	0.9333	0.9677	0.9841
2.5	0.7143	0.8974	0.9606	0.9845	0.9938
3	0.75	0.9231	0.975	0.9917	0.9973
3.5	0.7778	0.9403	0.9832	0.9952	0.9986
4	0.8	0.9524	0.9882	0.9971	0.9993
4.5	0.8182	0.9612	0.9914	0.9981	0.9996
5	0.8333	0.9677	0.9936	0.9987	0.9997

A decline in the number of infected individuals occurs when the CNC is clearly less than one. The inequalities solved for Sn in that case are shown in Figure 10. This indicates the minimum test sensitivity required to achieve a reduction in the number of infected individuals. Therefore, this sensitivity has been named sensitivity needed to control (SNC). In an extremely simple example, Table 2 specifically estimates the SNC considering only the two factors Rt and k. It is suggested that since the sensitivity of PCR testing in the early stages of infection was considered to be around 70%, if this were the reality, effective infection control through PCR testing was only feasible in a limited situation where k = 2 and Rt around 2.

The formulation of CNC and SNC is a significant achievement of this research. First, previous epidemio-

logical estimation models for infectious diseases were unclear about how the accuracy of testing impacted estimates, but the new theory in this study clarified the limitations of testing accuracy in administrative testing strategies. Second, it can be applied not only to estimating the number of infected individuals but also to estimating the cost-effectiveness of testing strategies. Third, the obtained formulas are universal and can be applied in any country or region. In other words, as long as the estimates of each parameter in the formulas are available, it is possible to determine whether the pandemic can be controlled through testing at any given point, in response to epidemiological changes.

Figure 11 shows the estimated cost-effectiveness of PCR testing in a simple analytical model assuming a 10-day QALY loss in cases of COVID-19 infection. In this case, the incremental cost-effectiveness ratio (ICER) was estimated by dividing the additional costs required to conduct PCR testing by the QALY loss avoided through the identification of infected individuals via PCR testing. As a result, one example of specific basic analysis illustrated in Figure 12 shows that the ICER is approximately $50,000 per QALY. This indicates that the cost-effectiveness of PCR testing is

$$\mathrm{ICER} = \frac{\text{Total costs additionally needed for diagnostic screening}}{\text{Saved QALYs per person by detecting infection} \times \text{Total number of cases prevented}}$$

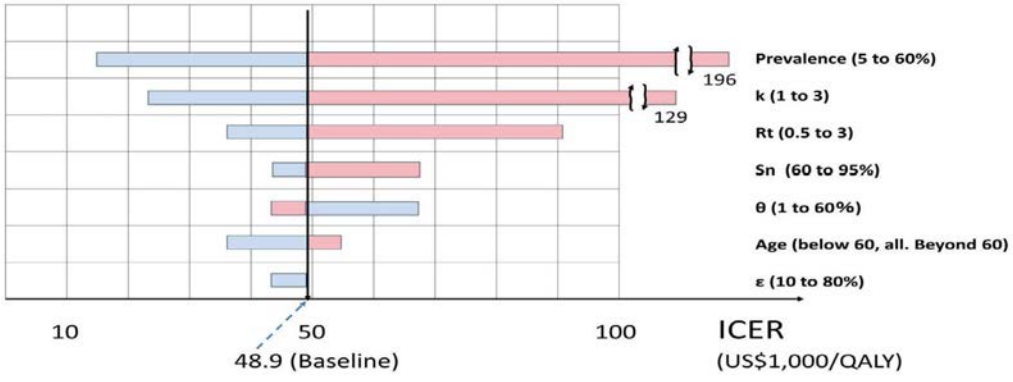
$$= \frac{M\,(C_t+C_d+C_{id})}{(Q)(D^+)(S_n)\{1-R_t^k\,(1-\theta(1-\varepsilon))^k\} \,/\, \{1-R_t\,(1-\theta(1-\varepsilon))\}},$$

where the saved QALYs per person is given with $Q = 10(1-U)/365$.

出典）Kamae I, M Kobayashi, R Watanabe: Cost-effectiveness Formulation of PCR-test Screening for COVID-19 Regarding Multiple Factors in Epidemic. Research Poster EE28, ISPOR Europe 2023, Copenhagen, Denmark, Nov 13, 2023.

Figure 11. The formula for the ICER of PCR test

- C_t, C_d, and C_{id} :a test-kit cost, direct costs, and indirect costs, respectively.
- The other parameters except Q, ε and U: the same as in Figure 1.
- ε: evasion rate of viruses from vaccines or any immunity protection. In case of no vaccines available or no immunity protection, let ε be 1 and when vaccination is perfectly preventable from infection, ε is 0.
- U: expected utility of the infected patients. Assume the utility of patients is decreased with 1-U in ten-days. Then Q indicates QALYs lost per patient in case of short COVID which has no complications sustained.



・The baseline analysis is conducted with PCR-test sensitivity of 85%, $C_t+C_d+C_{id}$ =US$200(￥30,000), Prevalence=40% (M=5000, D^+=2000), U=0.667, Rt=2, k=2, θ=20%, ε=10%. Then the ICER was US$48,912/QALY (￥7,336,797;1US$= ￥150).
・The sensitivity analysis by age is conducted for three groups: younger than 60 y.o., all ages, and older than 60 y.o. with U= 0.695, 0.667, and 0.578, respectively.
・The 'red' bars represent the range of small values for a parameter, while the 'blue' ones for high values.

Figure 12. One-way sensitivity analysis and the Tornado diagram for the multiple parameters.

neither particularly good nor particularly bad. However, Figure 12 also simultaneously presents the results of a sensitivity analysis regarding how much the ICER from the basic analysis changes when each parameter value varies. It was found that the prevalence has the greatest impact on the change in ICER. With a prevalence of 5%, the ICER becomes a high value of $196,000/QALY, indicating very poor cost-effectiveness, while at 60%, it improves to around $15,000/QALY, demonstrating very good cost-effectiveness. The magnitude of influence decreases in the order of the spread of infection k, effective reproduction number Rt, and test sensitivity Sn, while the virus's immune evasion rate ε has almost no effect. Table 3 shows the estimated ICER across different scenarios considering the waves of infection in Japan from the first wave to the eighth wave, including 1) all generations, 2) those aged 60 and over, and 3) considering post-COVID (long-COVID) symptoms. The Rt value was derived from governmental statistics using real data, while other parameters were provisionally set with plausible values based on the period. As a result, it became evident that cost-effectiveness tends to improve in the order of high-risk groups: those aged 60 and over, and further for those with post-COVID symptoms.

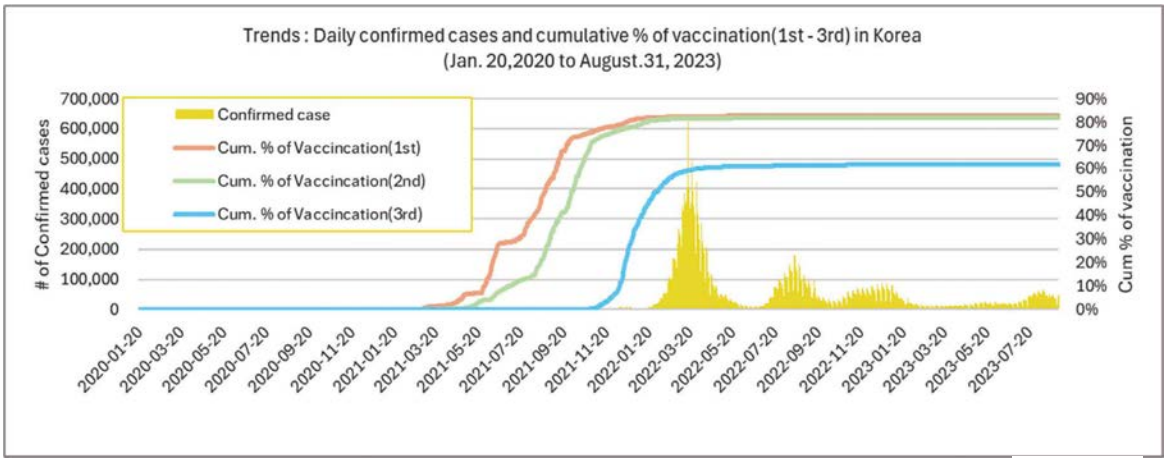
In contrast to Japan, Korea, which received acclaim for its early infection control measures, was compared using the same analytical model as Japan. According to epidemiological statistics on vaccination in South Korea[14], as shown in Figure 13, the vaccination rates in Korea declined as the vaccination rounds progressed, similar to Japan, but a trend was observed where the repeated waves of infection gradually diminished, unlike in Japan. Regarding the cost-effectiveness of PCR testing, as shown in Table 4, a similar trend was seen where the cost-effectiveness improved in a high-risk order: older adults aged 60 and above, and even more so for those with post-COVID sequelae, compared to the entire population. However, due to a very high Rt value in the early stages of infection in Korea, it became clear that the cost-effectiveness of PCR testing was best during the first wave, revealing patterns that differed from those in Japan.

In Taiwan, which is said to have quickly succeeded in the social information systematization of quarantine, an attempt was made to validate its quarantine system using a modified SEIR model (an epidemiological infectious disease model). The classical SEIR model assumes four populations: 1) Susceptible individuals (S; susceptible: a population that can get infected), 2) Exposed individuals in the latent phase (E; exposed: a group that has been infected but is not yet infectious), 3) Infectious individuals (I; infective: a population that has been infected and is infectious), and 4) Recovered and immune individuals (R; recovered: a population

Table 3. Scenario analysis of ICERs of PCR test from the 1st 2020 to 8th 2023 surge of COVID-19 in Japan

- The estimates of Rt are employed from government statistics, while plausible values are assigned for the other parameters such as prevalence, k, θ, and ε to carry out example calculations. The test sensitivity Sn is set with 85% as a constant.
- Assume that COVID causes the reduction of utility (i.e., 1-U = 0.333) in 10 days with 90% chance by short COVID, while the same reduction in 90 days with 10% chance by long COVID. Then the expected utility reduction is estimated with 0.598.
- The 'yellow' cells mean the ICER in the range between 50, 000 and 100,000 US$/QALY, while the 'blue' ones in the range lower than 50,000 US$/QALY.

Surge	Rt	Prevalence	k	θ	ε	ICER (US$/QALY)		
		%		%	%	All age groups	Older than 60	Adjusted by long COVID
1st (up-phase) APR 5, 2020	2.3	5	2	1	100	156,518	123,473	86,955
1st (down-phase) MAY 11, 2020	0.52	10	2	10	100	169,905	134,033	94,392
5th (up-phase) AUG 1, 2021	1.79	20	2	60	10	70,817	55,865	39,343
6th (up-phase) JAN 9, 2022	2.04	20	2	60	20	62,659	49,430	34,811
7th (up-phase) JUL 12, 2022	1.24	20	2	40	30	68,220	53,817	37,900
8th (down-phase) MAY 8, 2023	1.01	10	2	40	40	146,105	115,258	81,169



Reference: Public Data Portal, Korea Disease Control and Prevention Agency (KDCA)_COVID-19 Vaccination Status, https://www.data.go.kr/data/15078166/openapi.do

Figure 13. Covid-19 past in South Korea: Vaccination

Table 4. Scenario analysis of ICERs of PCR test in Korea

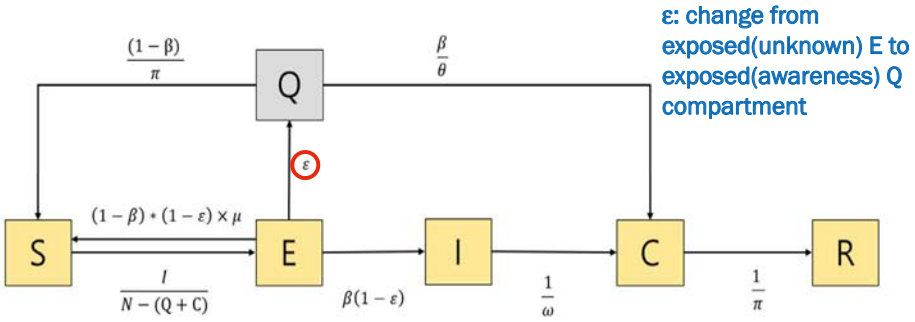
Source) Jeonghoon Ahnn

						ICER(US$/QALY)		
surge	Rt	prevalence	k	θ	ε	All age	Older than 60	Adjusted by long COVID
1st	5.65	5	2	1	100	24,278	19,285	13,488
2nd	1.87	10	2	10	100	56,253	44,685	31,252
3rd	2.12	20	2	60	10	53,717	42,670	29,843
4th	1.30	20	2	60	20	72,152	57,314	40,084
5th	1.17	20	2	40	30	75,540	60,005	41,966
6th	1.38	20	2	40	40	68,792	54,645	38,218
7th	1.28	10	2	40	50	71,614	56,887	39,785

Green cell: Cost effective at the Korean threshold of KRW 30,500,000 (USD 23,462).

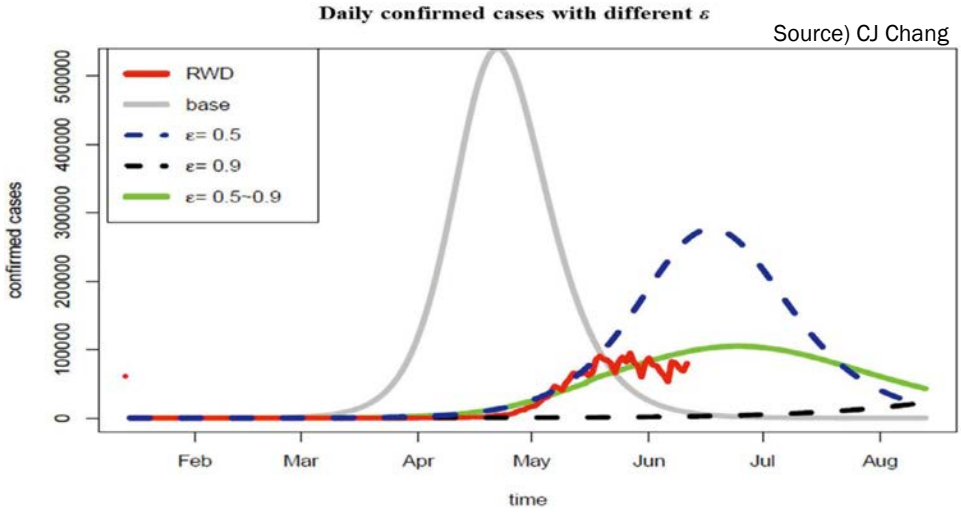
that has recovered from the disease and has retained immunity). The model describes the transitions between these populations with differential equations that change over time. The Taiwanese group devised a modified model in which the latent phase population E transitions to a population Q of latent individuals, who realized they were infected during the latent period, with a parameter ε, as shown in Figure 14. This modification aimed to align real data from Taiwan with the analytical model. As a result, it was found, as shown in Figure 15, that simulation results began to approximate real data when ε was in the range of 0.5 to 0.9. Estimating this ε by country and by month, it was found that from around August 2022 onwards, Taiwan, Singapore, Japan, and South Korea exhibited similar changes, while the UK followed a different pattern as shown in Figure 16. This might suggest that the social situation regarding people recognizing their infections through PCR testing has differed between Asian countries and the UK. Further analysis remains for the future.

A team from Singapore, which is said to have swiftly established an excellent testing system, analyzed the relationship between the accuracy of quarantine and medical economic benefits based on the Border Control Model. As shown in Figure 17, the simulation results indicated that the higher the sensitivity of the tests, the fewer false-negative travelers were



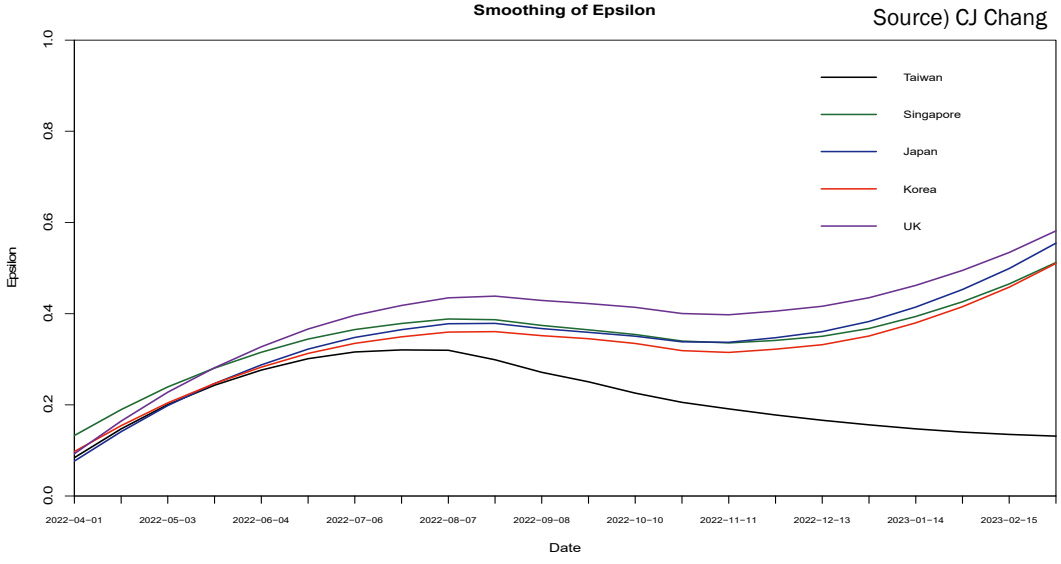
Source) CJ Chang

Figure 14. Modified SEIR model of Covid-19 transmission in Taiwan



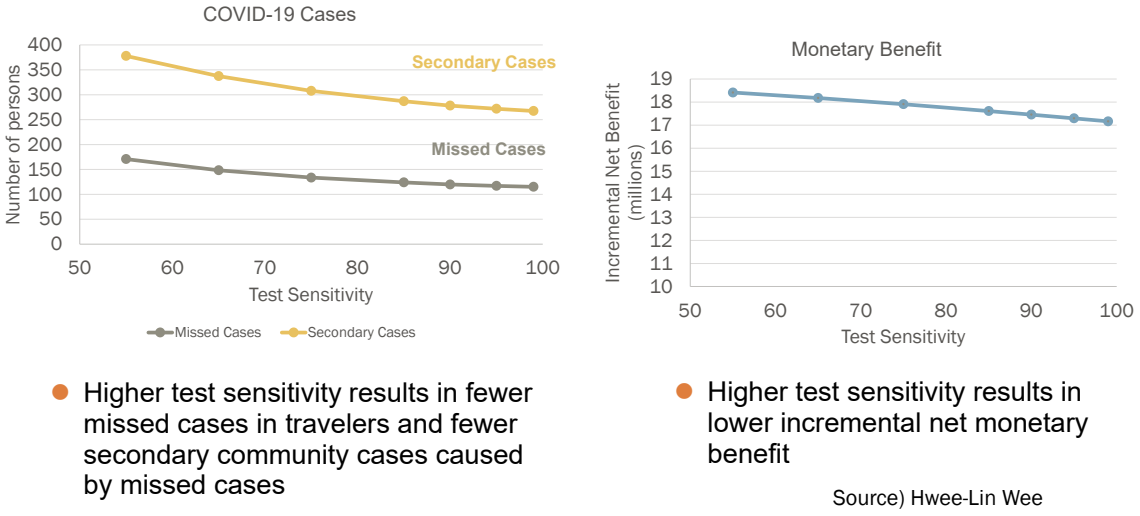
Source) CJ Chang

Figure 15. Real world data with various estimated ε values



Source) CJ Chang

Figure 16. Estimated ε values from other countries



- Higher test sensitivity results in fewer missed cases in travelers and fewer secondary community cases caused by missed cases

- Higher test sensitivity results in lower incremental net monetary benefit

Source) Hwee-Lin Wee

Figure 17. Effect of diagnostic test sensitivity on secondary cases and monetary benefit in Singapore quarantine system

missed, which in turn led to a reduction in the number of secondary infections. Furthermore, when estimating the cost-effectiveness using net monetary benefits as an indicator, it was found that as the sensitivity of PCR tests improved, the cost-effectiveness also improved. These results were consistent with the analysis of the Japanese case.

The results achieved by the Asia group are summarized as follows:

-The Japanese team, which is a subgroup of Asia, formulated a predictive formula for changes in the number of infected individuals considering various epidemiological factors such as the virus's infectivity, prevalence, and the degree of immunity and immune evasion. Using that predictive formula, they developed a method to determine the lower limits of PCR test accuracy, which can contain infections, and the incremental cost-effectiveness ratio (ICER) as a cost-effectiveness indicator.

-The value of diagnostic testing can be measured by considering multiple factors involved in infections, applicable at any stage of an infectious disease outbreak and potentially relevant to any country in the future.

-Although the PCR testing strategies in Japan, South Korea, and Singapore cannot necessarily be said to have excellent cost-effectiveness, improving test sensitivity could enhance efficiency.

-A cascade testing system that can improve test sensitivity and predictive values should be considered in preparation for the next pandemic.

-The analysis of the temporal changes of the parameter ε newly introduced to the quarantine systems in Taiwan is useful for understanding the dynamic effects of various NPIs, but it remains a challenge for the future.

○North America group

The North America group not only conducted a systematic literature review but also carried out a review utilizing AI (artificial intelligence). Additionally, they attempted to create a COVID-19 simulation model that can reproduce observed data and make predictions in order to estimate the value of rapid vaccine development. In particular, they examined the impact of early vaccination against the pandemic. As a result, the following findings were obtained:

-In the literature search using AI, it was shown that vaccines have a certain effectiveness. For example, Pierre V et al.[62] conducted a meta-analysis of 58 studies on primary series vaccination and booster vaccination from January 1, 2021, to March 10, 2023. As a result, it was recognized that booster vaccination has some effectiveness compared to only primary vaccination, and it was verified that when a booster dose was given after the primary vaccination, it had a significant effect compared to no vaccination at all. However, when comparing the vaccinated group and the unvaccinated group, no particular difference in the impact of the vaccine was observed in either group. Furthermore, there was little reporting on the broader economic

impact. It was suggested that the lack of expected evidence regarding the vaccine's effectiveness might be due to the strong anti-vaccine movement in North America, which could have hindered the vaccines from functioning effectively.

-Analyzing and simulating the statistics of COVID-19 cases in North America using the SEIR model was particularly challenging in the early stages due to many unknowns in the data. However, as data accumulated during the later stages of the pandemic, modeling became possible with data from certain regions of Canada, the United States, and Mexico.

-To respond to the pandemic, it is believed that creating a series of models corresponding to various expected infection patterns to make early predictions is the best approach. However, in reality, it became apparent that during the modeling of the early effects of vaccination, it was challenging to obtain quantitative data on changes in model parameters and interactions with NPIs, leading to many unresolved issues such as the limitations of the SEIR model and changes in people's socio-psychological behavior choices in response to the pandemic.

4. Main Publications and Conference Presentations

○Publications

1. Kamae I. A Theory of Diagnostic Testing to Stop the Virus Spreading: Evidence-based Reasoning to Resolve the COVID-19 Crisis by Testing. The Keio Journal of Medicine 71(1): pp. 13-20, 2022. DOI: 10.2302/kjm.2021-0009-IR
2. Brådvik G, Augustsson M, Lindgren P, Persson U: Swedes stayed at home during the pandemic – regardless of regulations. Health Economics, Läkartidningen. 2024; 121:24085; Läkartidningen 50-52/2024; Lakartidningen.se 2024-12-05 [Accessed on Aug 19, 2025] https://lakartidningen.se/halsoekonomi/2024/12/svenskar-stannade-hemma-under-pandemin-oavsett-regleringar/
3. Persson U, Olofsson S, Yan Gu N, Gong CL, Jiao X, Hay JW. Quality of Life in the Swedish General Population During COVID-19 - Based on pre- and post-pandemic outbreak measurement. Nordic Journal of Health Economics. 2021; 9(1): 56-73.
4. Brådvik G, Lindgren P, Persson U. Varför stängde västeuropeiska länder ned olika mycket under 2020? Ekonomisk Debatt. 2022; no 6 vol 50: 54-67. https://www.nationalekonomi.se/wp-content/uploads/2022/11/50-8-gbplup.pdf
5. Caro JJ, Möller J, Santhirapala V, et al. Predicting Hospital Resource Use During COVID-19 Surges: A Simple but Flexible Discretely Integrated Condition Event Simulation of Individual Patient-Hospital Trajectories. Value Health. 2021; 24(11): 1570-1577. doi: 10.1016/j.jval.2021.05.023

○Conference presentations

6. Kamae I: How did The Analysis of Dynamic Processes of Virus Transmission: How Could Diagnostic Tests and Vaccinations Stop COVID-19 Pandemic? Research Poster EPH65, ISPOR 2023, Boston, USA, May 8, 2023.
7. Kamae I, M Kobayashi, R Watanabe: Cost-effectiveness Formulation of PCR-test Screening for COVID-19 Regarding Multiple Factors in Epidemic. Research Poster EE28, ISPOR Europe 2023, Copenhagen, Denmark, Nov 13, 2023.
8. Kamae I, Ahn J, M Kobayashi: Learning from the COVID-19 pandemic and designing a new HEOR research model: What is the role of real-world evidence and how does it work? Breakout Session, ISPOR Real-World Evidence Summit 2025, Tokyo, Japan, Sep 29, 2025.

5. Future Challenges, Prospects, and Recommendations

Since COVID-19 was a pandemic caused by a novel coronavirus that humanity had never experienced before, there was very little accumulated scientific statistical data on various epidemiological factors such as the toxicity of the virus, routes of infection, modes of transmission, transmissibility and speed, mutation risks, and the degree of immune evasion. Therefore, a significant portion of the analyses in this study relies on limited available data, which is a drawback of the model analyses in this research. As a future challenge, it will be necessary to further validate the results using unbiased real-world data.

The research results of this study are as described above, and each research outcome will be beneficial individually in the event of future pandemics. In particular, the main achievement of the Japanese team is the theoretical construction of a new infectious disease transmission model, which is considered to have intrinsic value in the theory itself. However, it is beyond dispute that any theory should undergo validity verification through data in various forms. In that sense, it can be said that various challenges remain for the future.

Researchers from three groups in Europe, North America, and Asia involved in this study not only pre-

sented individual research findings but also engaged in comprehensive discussions, making the following recommendations for the future:

1. Consideration of social psychological and economic aspects

- The effectiveness or ineffectiveness of various COVID-19 measures should be quantitatively verified.
- It is necessary to prepare to avoid panic and understand people's behavior towards NPIs.
- Information should be made public, and there is a need to stimulate evidence-based decision-making rather than speculation or subjective judgment.
- Effective interventions resulted in a loss of quality of life (QOL) related to health. Health economists need to analyze and present the balance between effectiveness and cost based on scientific evidence.
- Having information to minimize the impact on GDP and quality of life can help in understanding the negative effects of preventive intervention measures and finding ways to mitigate them. This is important as it is difficult to reach a social consensus on how far we can tolerate the continuous rise in mortality rates.

2. Points to consider for specific measures

- Vaccination is extremely important. We must prepare to accelerate the establishment of prompt testing systems and vaccine development as much as possible. With the capacity for vaccine development and distribution, we can reduce the loss of QALYs and save economic costs. However, since vaccines are only one factor in epidemiology, we should use predictive models obtained from this study to evaluate the impact of vaccines.
- Identify the weaknesses in current infection prevention measures and strengthen them (e.g., improve indoor ventilation systems in schools to prevent airborne infections in the workplace).
- Evidence-based guidelines are required to overcome future pandemics.
- The practical application of the quarantine and infection control theory developed by the Japanese team in this study should be considered for practical application. (e.g., learning and practice by public infectious disease control teams in each country).

3. Precautions when facing a new pandemic

- In respiratory pandemics, the supply and use of effective non-woven masks became the first important non-pharmaceutical intervention (NPI). To identify this initial critical NPI, a multi-faceted understanding of the pandemic's pathology, epidemiology and public health, economic factors, and the realistic availability of medical resources is necessary.
- While early implementation of the first important NPI is essential in the initial stages of a pandemic, it is also crucial to recognize the efficiency and limitations of that intervention, as this will be important for decision-making regarding the introduction of subsequent NPIs.
- The government should implement measures that balance healthcare and the economy, following the principles and guidelines of quarantine rather than political considerations, which requires decision-making based on scientific evidence by dedicated teams of experts.

Additionally, the Europe group has decided to conduct the following research presentations and paper writing beyond the period of three years:

1. Covid-19 pandemic across the EU: how did we adapt our physical interaction? (submitted)
2. Covid-19 pandemic across the EU: what was the GDP cost of NPIs and change in behaviour? (submitted)
3. The health loss during Covid-19 in Sweden and Norway (planned)
4. The differences in behaviour and mortality between and within the Nordic countries during the Covid-19 pandemic (planned)

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References

*Asia group

1. Coronavirus Resource Center: Johns Hopkins University. https://coronavirus.jhu.edu/
2. Day M: Covid-19: Identifying and isolating asymptomatic people helped eliminate virus in Italian village. BMJ 2020; 368: m1165. DOI:10.1136/bmj.m1165
3. Harvard University. Testing & Tracing. https://www.harvard.edu/coronavirus/testing-tracing/
4. WHO: Covid-19 case definitions. https://www.who.int/publications/i/item/WHO-2019-nCoV-Surveillance_Case_Definition-2020.2
5. Straus SE, Glasziou P, Richardson WS, Haynes RB. Evidence-Based Medicine: How to Practice and Teach EBM. 5th edn, Elsevier,2018.
6. West CP, Montori VM, Sampathkumar P: COVID-19 testing: the threat of false-negative results. Mayo Clin Proc 2020; 95: 1127-1129. PMID:32376102, DOI: 10.1016/j.mayocp.2020.04.004
7. Arevalo-Rodriguez I, Buitrago-Garcia D, Simancas-Racines D, Zambrano-Achig P, Del Campo R, Ciapponi A, Sued O, Martinez-Garc L, Rutjes AW, Low N, Bossuyt PM, Perez-Molina JA, Zamora J: False-negative results of initial RT-PCR assays for COVID-19: a systematic review. PLoS One 2020; 15: e0242958, DOI:10.1101/2020.04.16.20066787
8. Padhye NS: Reconstructed diagnostic sensitivity and specificity of the RT-PCR test for COVID-19. https://www.medrxiv.org/content/10.1101/2020.04.24.20078949v2
9. Office for National Statistics: UK: COVID-19 Infection Survey: methods and further information. https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/methodologies/covid19infectionsurveypilotmethodsandfurtherinformation#test-sensitivity-and-specificit
10. Watson J, Whiting PF, Brush JE: Interpreting a COVID-19 test result. BMJ 2020; 369: m1808. DOI:10.1136/bmj.m1808
11. Ontario Public Health: COVID-19 Laboratory Testing Q&As. https://www.publichealthontario.ca/-/media/documents/lab/covid-19-lab-testing-faq.pdf?la=en&sc_lang=en&hash=F2F1C5303919FC691AB6B062AF922E42
12. Nishiura H, Inaba H: Prediction of infectious disease outbreak with particular emphasis on the statistical issues using transmission model. Proc Inst Stat Math 2006; 54: 461.480 (in Japanese; abstract in English).
13. Nature. Delta coronavirus variant: Scientists brace for impact.News 22 June 2021. https://www.nature.com/articles/d41586-021-01696-3 (Accessed 2021.07-12).
14. Public Data Portal, Korea Disease Control and Prevention Agency (KDCA)_COVID-19 Vaccination Status, https://www.data.go.kr/data/15078166/openapi.do
15. World Health Organization: WHO Coronavirus (COVID-19) Dashboard.https://covid19.who.int
16. World Health Organization: https://www.who.int/fr/emergencies/diseases/novel-coronavirus-2019/advice-for-public. 2020.
17. Chung HW, Apio C, Goo T, Heo G, Han K, Kim T, Kim H, Ko Y, Lee D, Lim J et al: Effects of government policies on the spread of COVID-19 worldwide.Scientific Reports 2021, 11(1): 20495.
18. Zhang X, Ma R, Wang L: Predicting turning point, duration and attack rate of COVID-19 outbreaks in major Western countries. Chaos, Solitons & Fractals 2020, 135:109829.
19. Prem K, Liu Y, Russell TW, Kucharski AJ, Eggo RM, Davies N, Flasche S,Clifford S, Pearson CAB, Munday JD et al: The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan,China: a modelling study. The Lancet Public Health 2020, 5(5): e261-e270.
20. Coroiu A, Moran C, Campbell T, Geller AC: Barriers and facilitators of adherence to social distancing recommendations during COVID-19 among a large international sample of adults. PLOS ONE 2020, 15(10): e0239795.
21. Gualda E, Krouwel A, Palacios-Gálvez M, Morales-Marente E, Rodríguez-Pascual I, García-Navarro EB: Social Distancing and COVID-19: Factors Associated With Compliance With Social Distancing Norms in Spain.Frontiers in Psychology 2021, 12.
22. Papageorge NW, Zahn MV, Belot M, van den Broek-Altenburg E, Choi S, Jamison JC, Tripodi E: Socio-demographic factors associated with self-protecting behavior during the Covid-19 pandemic. J Popul Econ 2021, 34(2): 691-738.
23. Shao HL: Constructing a modified SEIR model to quantify Covid-19 pandemic management in Taiwan. National Digital Library of Theses and Dissertations in Taiwan: Chang Gung University; 2022.
24. Hsieh C-W, Wang M, Wong NWM, Ho LK-k: A whole-of-nation approach to COVID-19: Taiwan's National Epidemic Prevention Team. International Political Science Review 2021, 42(3): 300-315.
25. Montazeri A, Mohammadi S, M. Hesari P. et al. Exposure to the COVID-19 news on social media and consequent psychological distress and potential behavioral change. Scientific Reports 2023, 13, 15224.

*Europe group

26. Finkelstein A, Persson P, Polyakova M, Shapiro JM. A Taste of Their Own Medicine: Guideline Adherence and Access to Expertise. American Economic Review: Insights. 2022 December; 4(4): 507-26. https://www.aeaweb.org/articles?id=10.1257/aeri.20210591.
27. Google. Community Mobility Reports; 2022. Last accessed on 2023-09-22. https://www.google.com/covid19/mobility/.
28. Hale T, Angrist N, Goldszmidt R, Kira B, Petherick A, Phillips T, et al. A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). Nature human behaviour. 2021 Apr; 5: 529-38.

29. Eurostat. GDP and main components; 2024. Last accessed on 2024-06-17. https://ec.europa.eu/eurostat/databrowser/view/NAMQ_10_GDP__custom_10009559/default/table?lang=en.
30. Boumans M. Flattening the curve is flattening the complexity of covid-19. History and philosophy of the life sciences. 2021 Feb; 43: 18.
31. Eurostat. Excess mortality by month; 2024. Last accessed on 2024-02-21. https://ec.europa.eu/eurostat/databrowser/view/DEMO_MEXRT__custom_1210067/bookmark/table?lang=en&bookmarkId=fc27a3a9-082b-461d-830b-a4c7b36caf4f.
32. Statistics Sweden. D ¨oda per m ˚anad efter region, f ¨odelseregion, ˚alder, k ¨on, m ˚anad, tabellinneh ˚alloch ˚ar. Stockholm, Sweden; 2024. [Data accessed 2024-08-02 11:34:33 using pxweb R package 0.17.0]. https://api.scb.se/OV0104/v1/doris/sv/ssd/START/BE/BE0101/BE0101I/DodaManadReg.
33. Andersson FNG. Frivillig anpassning eller tvingande restriktioner? Overd ¨odligheten, pandemibek ¨ampningen och den ekonomiska utvecklingen i Europa under 2020. Statsvetenskaplig tidskrift. 2022; 124(2): 463-91.
34. European Commission. EU Vaccines Strategy; 2022. Last accessed on 2024-11-27. https://commission.europa.eu/strategy-and-policy/coronavirus-response/public-health/eu-vaccines-strategy_en.
35. Alina P, Enache A, Popa I, Antoniu S, Dragomir R, Burlacu A. Determinants of the Hesitancy toward COVID-19 Vaccination in Eastern European Countries and the Relationship with Health and Vaccine Literacy: A Literature Review. Vaccines. 2022 04; 10: 672.
36. Pizzato M, Gerli AG, La Vecchia C, Alicandro G. Impact of COVID-19 on total excess mortality and geographic disparities in Europe, 2020–2023: a spatio-temporal analysis. The Lancet Regional Health – Europe. 2024;44 (100996). https://www.thelancet.com/journals/lanepe/article/PIIS2666-7762(24)00163-7/fulltext.
37. The Economist. Covid-19 is now in 50 countries, and things will get worse. The Economist. 2020. https://www.economist.com/briefing/2020/02/29/covid-19-is-now-in-50-countries-and-things-will-get-worse.38
38. Eurostat. Individuals - devices used to access the internet; 2024. Last accessed on 2024-02-21. https://ec.europa.eu/eurostat/databrowser/view/isoc_ci_dev_i/default/table?lang=en.
39. Google. Covid 19 open data: Weather; 2022. Last accessed on 2023-09-22. Available from: https://github.com/GoogleCloudPlatform/covid-19-open-data/blob/main/docs/table-weather.md.
40. Irfan M, Razzaq A, Suksatan W, Sharif A, Madurai Elavarasan R, Yang C, et al. Asymmetric impact of temperature on COVID-19 spread in India: Evidence from quantile-on-quantile regression approach. Journal of thermal biology. 2022 Feb; 104: 103101.
41. WHO. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020; 2020. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020.
42. Eurostat. Population on 1 January; 2024. Last accessed on 2024-02-21. https://ec.europa.eu/eurostat/databrowser/view/tps00001/default/table.
43. Chen J, Gong CL, Persson U, Gu NY. A cross-country comparison of health-related quality of life in the United States, Sweden, and Norway during the first year of the COVID-19 pandemic. Archives of public health = Archives belges de sante publique. 2023 Apr; 81: 58.
44. OECD. Teleworking in the COVID-19 Pandemic: Trends and Prospects; 2021. https://ec.europa.eu/eurostat/databrowser/view/tec00001/default/table.
45. Simons G. Swedish Government and Country Image during the International Media Coverage of the Coronavirus Pandemic Strategy: From Bold to Pariah. Journalism and Media. 2020; 1(1): 41-58. Available from: https://www.mdpi.com/2673-5172/1/1/4.
46. Jonung L. Sweden's Constitution Decides Its Covid-19 Exceptionalism. Lund University, Department of Economics; 2020. 2020:11.
47. Lag (2021:4) om s ¨arskilda begr ¨ansningar f ¨or att f ¨orhindra spridning avsjukdomen covid-19; 2021. Accessed: 2024-11-27. Svensk f ¨orfattningssamling. https://www.riksdagen.se/sv/dokument-och-lagar/dokument/svensk-forfattningssamling/lag-20214-om-sarskilda-begransningar-for-att_sfs-2021-4/.
48. Socialdepartementet. Tillf ¨alliga nedst ¨angningar och f ¨orbud f ¨or att f ¨orhindra spridning av sjukdomen covid-19; 2021. Promemoria, S2021/01499. Regeringskansliet. https://www.regeringen.se/contentassets/9a889a92d3f74169a048fc6aa2338a1f/tillfalliga-nedstangningar-och-forbud-for-att-forhindra-spridning-av-sjukdomen-covid-19.pdf.
49. Briggs AH, Goldstein DA, Kirwin E, Meacock R, Pandya A, Vanness DJ, et al. Estimating (quality-adjusted) life-year losses associated with deaths: With application to COVID-19. Health Economics. 2021; 30(3): 699-707. https://onlinelibrary.wiley.com/doi/abs/10.1002/hec.4208.
50. Garratt A, Hansen T, Augestad L, Rand K, Stavem K. Norwegian population norms for the EQ-5D-5L: results from a general population survey. Quality of Life Research. 2022 02; 31: 1-10.
51. Statistics Norway. Døde, etter kjønn og 1- ˚arige aldersgrupper 1986-2023. Oslo, Norway; 2024. Last accessed on 2024-09-03. https://data.ssb.no/api/v0/no/table/10325.
52. Eurostat. Labour market slack by sex and age - quarterly data; 2024. Last accessed on 2024-06-17. https://ec.europa.eu/eurostat/databrowser/view/lfsi_sla_q/default/table?lang=en&category=labour.employ.lfsi.une.39
53. Dingel JI, Neiman B. How many jobs can be done at home? Journal of Public Eco-nomics. 2020; 189: 104235. https://www.sciencedirect.com/science/article/pii/S0047272720300992.
54. John H, Dragos, A, Elisa S. Recovery from COVID-19: The changing structure of employment in the EU; 2022. Eurofound. https://www.eurofound.europa.eu/en/publications/2022/recovery-covid-19-changing-structure-employment-

eu#:~:text=andlabourmarkets-, RecoveryfromCOVID-19: Thechangingstructure,ofemploymentintheEU&text=European labourmarketshaverecovered,almostatpre-crisislevels.
55. Eurostat. Gross domestic product at market prices; 2024. Last accessed on 2024-06-06. https://ec.europa.eu/eurostat/databrowser/view/tec00001/default/table.
56. Commission E. Report on the European instrument for Temporary Support to mitigate Unemployment Risks in an Emergency (SURE) following the COVID-19 outbreak pursuant to Article 14 of Council Regulation (EU) 2020/672 SURE after its sunset: final bi-annual report. Brussels; 2023. COM (2023) 291 final.
57. FEDS Notes. Why is the U.S. GDP recovering faster than other advanced economies?; 2024. Last accessed on 2024-08-28. https://www.federalreserve.gov/econres/notes/feds-notes/why-is-the-u-s-gdp-recovering-faster-than-other-advanced-economies-20240517.html.
58. Adascalitei D, vacas soriano C, Staffa E, Hurley J. Telework and teleworkability during COVID: An analysis using LFS data. Eurofound working paper. 2022 07.
59. Chernozhukov V, Kasahara H, Schrimpf P. Causal impact of masks, policies, behavior on early covid-19 pandemic in the U.S. Journal of Econometrics. 2021; 220(1): 23-62. Pandemic Econometrics. https://www.sciencedirect.com/science/article/pii/S0304407620303468.
60. Li Y, Liang M, Gao L, Ayaz Ahmed M, Uy JP, Cheng C, et al. Face masks to prevent transmission of COVID-19: A systematic review and meta-analysis. American Journal of Infection Control. 2021 Jul; 49(7): 900-6. https://doi.org/10.1016/j.ajic.2020.12.007.
61. Jefferson T, Dooley L, Ferroni E, Al-Ansary L, van Driel M, Bawazeer G, et al. Physical interventions to interrupt or reduce the spread of respiratory viruses. Cochrane Database of Systematic Reviews.2023; (1). https://doi.org//10.1002/14651858.CD006207.pub6.

*North America group

62. Pierre V, Draicab F, Di Fusco M, Yang J, Nunez-Gonzalez S, Kamara J, Lopez S, Moran MM, Nguyen J, Alvarez P, Cha-Silva A, Gavaghan N, Yehoshua A, Stapleton N, Burnett H. J MED ECON 2023 Doi 10.1080/13696998.2023.2281882
63. Yang J, Vaghela S, Yarnoff B, et al. Estimated global public health and economic impact of COVID-19 vaccines in the pre-omicron era using real-world empirical data. Expert Rev Vaccines. 2023; 22(1): 54-65. doi:10.1080/14760584.2023.2157817
64. Matza LS, Stewart KD, Naegeli AN, et al. Qualitative interviews to evaluate content validity of the ACTIV-2 COVID-19 Symptom Diary (ACSD). J Patient Rep Outcomes. 2023; 7(1): 8. Published 2023 Jan 31. doi:10.1186/s41687-022-00535-x
65. Mendes D, Chapman R, Aruffo E, et al. Public health impact of UK COVID-19 booster vaccination programs during Omicron predominance. Expert Rev Vaccines. 2023; 22(1): 90-103. doi:10.1080/14760584.2023.2158816
66. Keeley TJH, Satram S, Ghafoori P, et al. Content validity and psychometric properties of the inFLUenza Patient-Reported Outcome Plus (FLU-PRO Plus©) instrument in patients with COVID-19 [published online ahead of print, 2023 Jan 27]. Qual Life Res. 2023;1-13. doi:10.1007/s11136-022-03336-3
67. Di Fusco M, Marczell K, Deger KA, et al. Public health impact of the Pfizer-BioNTech COVID-19 vaccine (BNT162b2) in the first year of rollout in the United States. J Med Econ. 2022; 25(1): 605-617. doi:10.1080/13696998.2022.2071427
68. Mendes D, Chapman R, Gal P, et al. Public health impact of booster vaccination against COVID-19 in the UK during Delta variant dominance in autumn 2021. J Med Econ. 2022; 25(1): 1039-1050. doi:10.1080/13696998.2022.2111935
69. Tervonen T, Jimenez-Moreno AC, Krucien N, Gelhorn H, Marsh K, Heidenreich S. Willingness to Wait for a Vaccine Against COVID-19: Results of a Preference Survey. Patient. 2021; 14(3): 373-377. doi:10.1007/s40271-020-00483-y
70. Angelis A, Baltussen R, Tervonen T. The Need for Novel Approaches in Assessing the Value of COVID-19 Vaccines. Am J Public Health. 2021; 111(2): 205-208. doi:10.2105/AJPH.2020.306066

Malaria Eradication in the Era of COVID-19 Pandemic: a Study Integrating Sociological, Economic, and Medical Approaches to Overcome the Challenges in Tropical Africa

Grant Period: from December 1, 2021 through November 30, 2024
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Principal Researcher: Akira Kaneko
Specially Appointed Professor, Osaka International Research Center for Infectious Diseases/Graduate School of Medicine, Osaka Metropolitan University, Professor, Karolinska Institutet

Despite recent efforts to scale up rapid diagnosis and treatment and vector control measures, malaria persists in the Lake Victoria region of Kenya. We identified the following challenges: (1) a high proportion of asymptomatic infections, (2) insecticide resistance and outdoor feeding behavior of mosquito vectors, and (3) diverse behavioral patterns among residents. To address these challenges, we have evaluated two novel interventions through cluster randomized controlled trials. Insecticide-treated (OlysetPlus) ceiling nets have been shown to reduce *Plasmodium* infection and malaria incidence by half in the intervention areas on Mfangano Island, with high acceptance rates among residents. These nets are now being scaled up in the highly malaria-endemic inland area of Ndhiwa and in the Kagera region of Tanzania to contain artemisinin-resistant parasites. Economic interventions aimed to develop and validate mechanisms that promote proactive preventive behaviors and early treatment among residents by combining education and financial incentives. While educational materials were shown to be an effective tool for promoting behavioral change, further improvements in the design of financial incentives and additional validation are needed. The first malaria vaccine in history has finally been introduced in Africa, and its rollout is progressing in the target areas. However, there is no magic bullet for malaria. We propose a multifaceted malaria eradication strategy that integrates the new vector control measure of OlysetPlus ceiling nets with interventions such as vaccines and drugs, ensuring strong community participation.

1. Research Objectives

A review of global malaria and development trends over the past half-century reveals a striking divergence between Africa and Southeast Asia. Starting in 1980, malaria deaths gradually declined in Southeast Asia, accompanied by rapid economic development, while in Africa, deaths surged and development stagnated [Henley D. 2015; Murray CJ, et al. 2012]. Sachs demonstrated that in the cycle of malaria and poverty, the vector of poverty caused by malaria is far more powerful, through multiple pathways including birth rates, productivity, absenteeism, and medical expenses [Sachs J, Malaney P. 2002] (Fig. 1).

After peaking in 2004, the number of deaths began to decline, but currently, 95% of deaths still occur among children under five in tropical Africa. However, the downward trend has plateaued since around 2015 and has slightly increased due to the COVID-19 pandemic. The SDGs aim to “End malaria by 2030,” but achieving this goal remains challenging. On the other

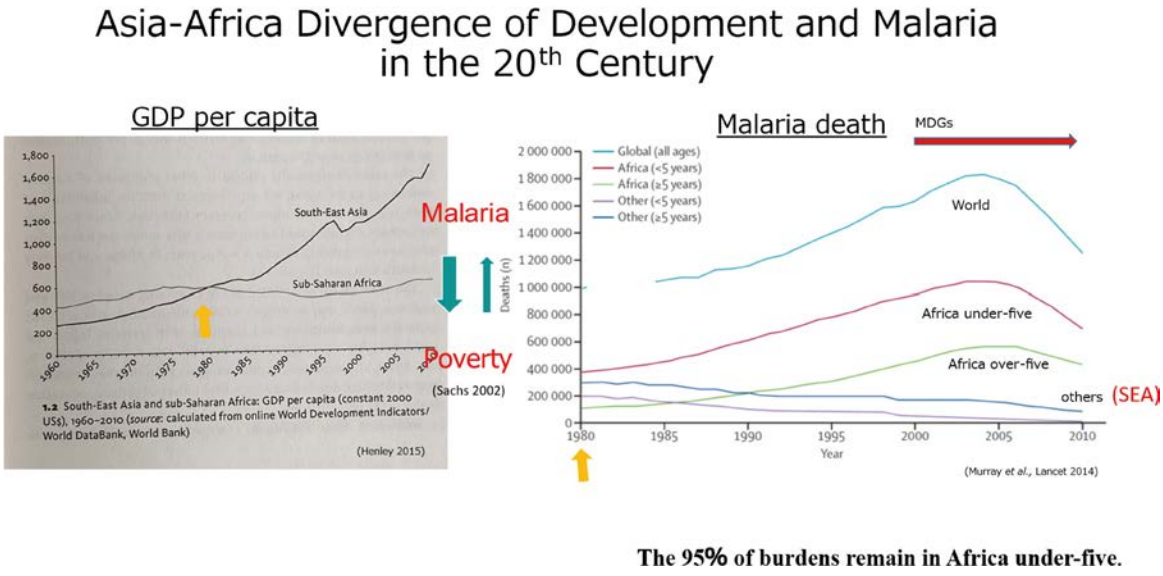


Fig. 1 Asia-Africa Divergence of Development and Malaria in the 20th Century

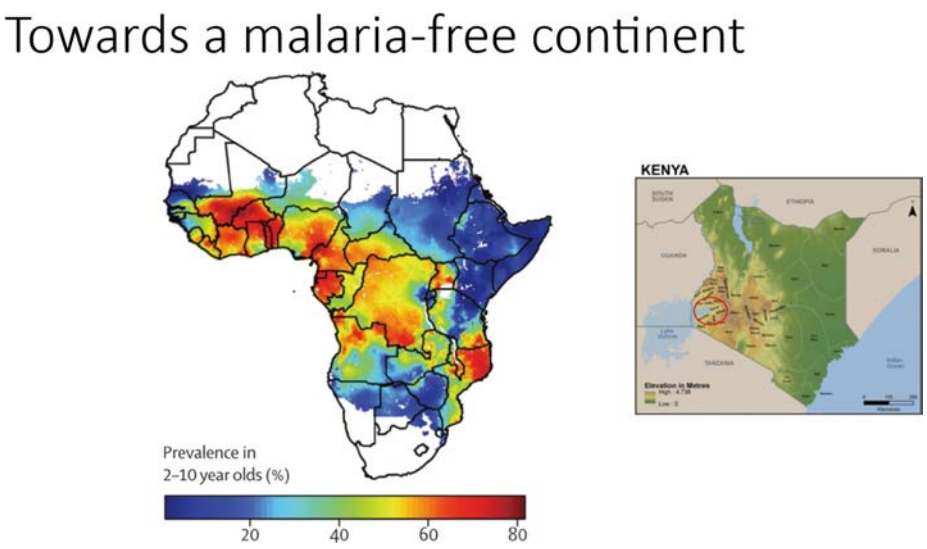


Fig. 2 The target area: high malaria-endemic communities along the Lake Victoria basin, Kenya

hand, there has been discussion about what might have been achieved if humanity had directed the same energy toward malaria as it did toward COVID-19 [Ntoumi F. 2020]. Additionally, the recent policy shift in the United States is having a significant impact on malaria control efforts on the ground [Symons TL, et al. 2025]. In this new situation, there is a need to accelerate malaria eradication and development in tropical Africa, and Japan's role is being questioned.

Our target area is Homabay County on the eastern edge of the malaria belt, on the shores of Lake Victoria in Kenya (Fig. 2). The area has a high rate of under-five mortality and a vicious cycle of poverty, with malaria being the leading cause of death.

In the target area, since 2000, effective measures have been scaled up, including early diagnosis and treatment using malaria rapid diagnostic tests (RDTs) and artemisinin-based combination therapy (ACT), vector control measures such as long-lasting insecticide-treated nets (LLINs) and indoor residual spraying (IRS), and intermittent preventive treatment for pregnant women (IPTp). Since 2012, we have conducted field investigations to examine why high malaria transmission persists [Idris ZM, et al. 2016, Idris ZM, et al.

2017]. Initially, we identified the following three issues as background factors. First, the presence of many asymptomatic infections, which are not detected by current diagnostics and treated accordingly but serve as sources of onward transmission. Second, insecticide resistance and the emergence of outdoor-biting mosquito vectors pose a significant threat to current vector control measures. Third, residents lack motivations to take preventive measures against malaria infections.

We aimed to develop an integrated malaria elimination strategy that combines medical interventions such as diagnosis, treatment, and vector control with interventions that encourage residents to take preventive actions on their own, addressing the unseen infections below the "tip of the iceberg".

The implementation framework involved collaboration between the Japanese side based in Osaka Metropolitan University and the Kenyan side, including Mount Kenya University, Homa Bay County Government, and the Kenya Medical Research Institute (KEMRI), working together with residents of the target communities.

2. Research Methods, Progress, and Achievements

2.1 New Mosquito Vector Control Measures

In the Lake Victoria region, large-scale distribution of long-lasting insecticidal nets (LLINs) by the National Malaria Control Program (NMCP) supported by the Global Fund and indoor residual spraying (IRS) programs by the US President's Malaria Initiative (PMI) have been implemented. However, these measures have not achieved effective control of malaria-transmitting mosquitoes due to issues such as insecticide resistance, compliance, cost, sustainability, and community acceptance.

We have been conducting field intervention trials to evaluate ceiling-mounted mosquito nets made from Olyset®Plus, a new mosquito control agent developed by Sumitomo Chemical Co., Ltd., as a complementary approach to address these issues [Kagaya W, et al. 2023]. In Africa, the widespread distribution of LLINs and IRS has led to the emergence of insecticide resistance in mosquito vectors. However, Olyset®Plus contains an insecticide (piperonyl butoxide: PBO) that is effective against insecticide-resistant mosquito vectors. On the other hand, even if mosquito nets are sufficiently available, their effectiveness may be compromised due to non-use or improper use. In this regard, covering the openings between the ceiling and the walls of a house with mosquito net material can prevent the entry of mosquito vectors and block transmission through insecticidal effects, thereby protecting even those who do not use mosquito nets from infection.

These effects were confirmed using ceiling nets

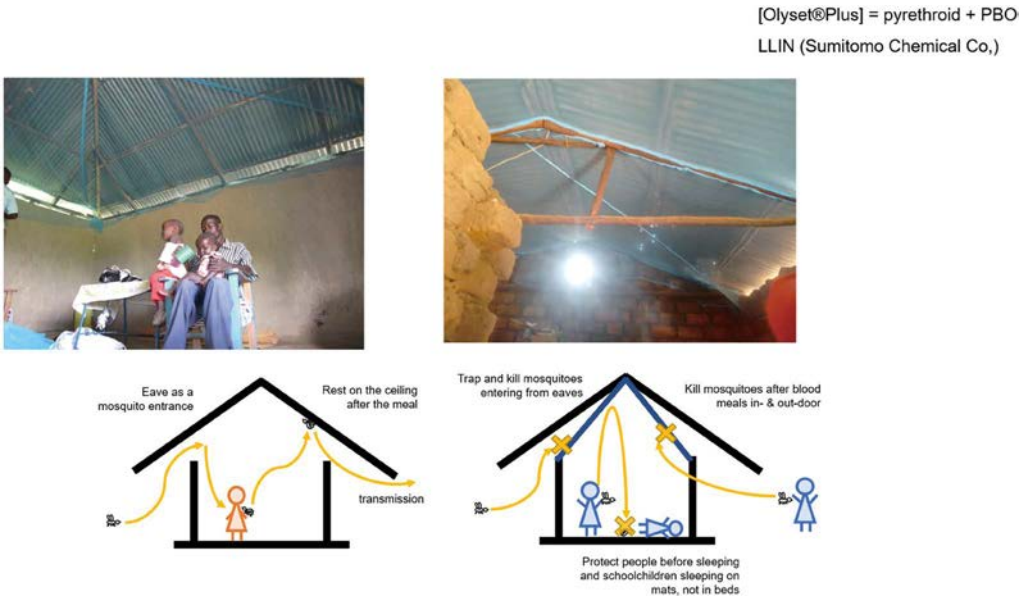


Fig. 3 Novel vector control: dual-insecticide-treated (Olyset®Plus) ceiling nets

made from standard Olyset mosquito net material in previous field intervention trials [Minakawa N et al. 2021]. The team has developed a new tool: Olyset®Plus ceiling net and has evaluated its effectiveness through a cluster randomized controlled trial. The study is being conducted in 20 clusters comprising 2,572 households centered around Wakla in the southeastern part of Mfangano Island [Kagaya W, et al. 2023]. A pre-intervention baseline survey (schools, communities) was conducted in October 2021, and the installation of Olyset®Plus ceiling net was completed in January 2022 (intervention: 1,247 eligible households). The primary monitoring indicators include malaria parasite infection rates (RDT, microscopy, PCR) from cross-sectional surveys of schoolchildren (12 elementary schools, every six months), malaria incidence rates from a longitudinal cohort (472 people, one-year follow-up), resident awareness, and vector mosquito indicators. From January 2022 onwards, monitoring was expanded to include monthly blood sampling by Community Health Volunteers (CHVs) in the cohort.

Olyset®Plus ceiling nets were installed in 1,006 households, achieving a coverage rate of 93.4%. The prevalence of malaria was assessed in 806 children in the control group and 831 children in the intervention group. The malaria prevalence rate by RDT 12 months after intervention was 30.1% (95% confidence interval: 27.1–33.3) in the control group and 16.4% (95% CI: 14.0–19.2) in the intervention group, with a prevalence ratio of 0.55 (95% CI: 0.33–0.91, p = 0.056).

Incidence was assessed in 206 participants in the control group and 266 in the intervention group. The malaria incidence rate during the 12-month follow-up period was 0.11 person-years per year (95% CI: 0.07–0.15) in the control group and 0.05 (95% CI: 0.02–0.09) in the intervention group, with an incidence rate ratio of 0.47 (95% CI: 0.24–0.95, p = 0.030).

Olyset®Plus ceiling nets demonstrated efficacy in preventing malaria infection when used in addition to existing malaria control measures. Based on these results, Olyset®Plus ceiling nets are now being deployed around Lake Victoria. One initiative is a new cluster randomized controlled trial in the Ndhiwa Subcounty, where IRS and the RTS,S/AS01 malaria vaccine have been deployed, to further confirm the effectiveness of Olyset®Plus ceiling nets [Ko Y et al. 2025]. Another initiative is the emergency deployment of Olyset®Plus ceiling nets in the Kagera region of Tanzania, which borders Uganda and Rwanda.

2.2 Emergency measures to contain artemisinin-resistant parasites

Artemisinin is currently the mainstay of first-line treatment for falciparum malaria, but artemisinin-resistant (ART-R) *P. falciparum* parasites were reported in 2009 along the Thailand-Cambodia border and have since spread, primarily in the Great Mekong Subregion. In 2021, ART-R was first reported in Africa, where malaria incidence and mortality rates are high [Stokes BH et al. 2022]. In the aforementioned Kagera region, the spread of ART-R has been confirmed. The current situation, where high prevalence and drug resistance are combined, evokes the dark history of chloroquine-resistant *P. falciparum* malaria parasites that emerged in Southeast Asia and spread to tropical Africa, leading to a sharp increase in deaths from the 1990s onward [Attaran A et al. 2004; Murray CJ et al. 2012] and represents a critical situation for the entire African continent. In response to a request from the Tanzanian Ministry of Health, a pilot introduction of Olyset®Plus ceiling nets was implemented in Kagera as an emergency measure to contain ART-R parasites. High acceptance among residents has also been demonstrated in Kagera.

2.3 Economic interventions

Based on insights from behavioral economics, this study aimed to develop policy tools to promote preventive actions and early treatment among residents in high-malaria-transmission areas [Matsumoto T et al. 2024].

In this study, malaria education content (EDU) on tablet devices was developed to strengthen knowledge about the disease as a measure to promote malaria prevention and early treatment. Furthermore, to verify behavioral change through monetary incentives, a conditional cash transfer (CCT) and lottery incentive scheme (LIS) targeting malaria-negative individuals were adopted.

The educational content incorporated two elements based on behavioral economics. First, it sought to evoke altruistic motives. Through messages such as “Let’s thoroughly prevent malaria for the sake of our

Fig. 4 Economic interventions in South Suba, Homabay County

families and the community," it encouraged behavior based on social norms. Second, it utilized loss aversion. By clearly indicating losses such as treatment costs, lost income, and lost educational opportunities for children, it emphasized the importance of preventive actions to remain malaria-free. In designing the incentive system, we introduced a lottery-based reward system, which has been reported to be effective in previous studies. In this scheme, the probability of winning is low but the reward is high, so we hypothesized that it could have a greater effect in changing bahaviors than CCT for the same expected reward amount, based on the behavioral economic cognitive bias of "overestimation of low-probability events."

The effects were verified through a randomized controlled trial (RCT) targeting South Saba, Homa Bay County, Kenya (Fig. 4). In the first intervention (June–July 2022), after a resident census and baseline survey, 1,728 households were selected from 92 clusters and assigned to the EDU+CCT group, the EDU+LIS group, or the control group. Post-intervention evaluations showed that educational content significantly improved malaria knowledge (correct response rate +15%) and increased mosquito net usage in the CCT group. However, no statistically significant reduction in infection rates measured by rapid diagnostic tests (mRDTs) was observed. Additionally, behavioral change effects in the LIS group were limited, indicating challenges in the design of reward amounts and distribution methods.

In the second intervention (January–February 2024), the CCT payment amount was increased to 300 Ksh, the LIS winning amount was increased to 3,000 Ksh, and the frequency of payment was added. As a result, the educational content again contributed to knowledge improvement, and its effects persisted for several months after the intervention. Knowledge improvement was associated with increased mosquito net usage rates and the frequency of adult assistance when children set up mosquito nets (adult support). However, the impact of monetary incentives on infection rates remained limited, with CCT slightly improving mosquito net usage and adult support, while the effects of LIS were small.

In conclusion, educational interventions were shown to contribute to knowledge improvement and preventive behavior improvement, but the effects of monetary incentives were limited, and a reexamination of the institutional design is necessary. In particular, it is noteworthy that LIS, which was found to be effective in disease prevention behavior in the study by Nyqvist et al. (2018), did not function well in this study. In Nyqvist et al.'s HIV/AIDS study, a lottery-based reward system contingent on negative STI test results was introduced, and preventive behavior improved significantly, particularly among men with low risk

aversion. The effectiveness of this mechanism can be attributed to the fact that HIV prevention relies on relatively single-shot decision-making, with a clear link to rewards, and that the target population was young adults, who are more receptive to the risk characteristics of lottery-based rewards. On the other hand, malaria prevention behaviors require repetitive and household-based actions such as using mosquito nets and regular medical visits, so the impact of temporary rewards was limited. Additionally, the target population included many risk-averse household heads and women, and the presence of asymptomatic infections and low risk awareness may have also influenced the results. Even with higher reward amounts, LIS may not have been sufficiently motivating due to the low probability of winning.

Malaria parasite infection rates are currently assessed using RDTs, but dried blood spots for PCR, which has higher detection sensitivity, are also being collected, and analysis is ongoing. In the future, infection rate assessments will include low-parasite-density infections that are not detected by RDTs but are detected by PCR.

2.4 Malaria Elimination Center Activities

The Malaria Eradication Center established within the Homabay County Hospital is being developed as a local field activity base. In particular, in collaboration with KEMRI and Mount Kenya University, the center is conducting activities such as measuring malaria infection rates among residents, mosquito vector counts, and microscopic and PCR diagnosis of malaria (sporozoite) carriage rates in mosquito vectors, as well as monitoring various intervention trials.

In addition, a system has been established to enable multifaceted monitoring by compiling and integrating data on health facilities related to malaria transmission, focusing on intervention areas. These activities have been carried out by multiple local medical personnel and young researchers, who have gained experience in basic research procedures and logical discussions.

At the laboratories within Homabay County Hospital and Mount Kenya University, the procurement of equipment was affected by the COVID-19 pandemic, resulting in some delays in the establishment of laboratory facilities. However, by July 2023, the laboratory at Mount Kenya University had been operational, and laboratory functions such as sample storage, PCR, and parasite culture had been established. The experimental system necessary for collecting basic molecular epidemiological information, including nucleic acid extraction from blood film samples, cDNA synthesis, and qPCR, has also been established. Analysis of field samples already collected has also begun under local leadership. Additionally, at Mount Kenya University, a serological multiplex analysis system has been established, and immunological analyses targeting cohort populations are underway. At the Homabay County Government Hospital, taking advantage of its proximity to the field site, preparations are underway to establish a system for isolating peripheral blood mononuclear cells (PBMC) samples and generating RNA sequencing libraries from a new cohort started in Suba South. Even after the project ends, research linking the field and cutting-edge laboratories, such as a single-cell level approach to asymptomatic infections, is expected to continue under Kenyan ownership.

3. Main Publications and Conference Presentations

[Original articles]

2025

- Ko YK, Gitaka J, Kanoi BN, Ngasala BE, Kanamori M, *Kagaya W*, Kaneko A. Previously undiagnosed disease "X" in the Democratic Republic of the Congo: malaria's potential role in the outbreak. *Open Forum Infect Dis*. Published April 18, 2025.
- *Kagaya W*. Low-density *Plasmodium falciparum* infection: "Even a parasite will turn". *Parasitol Int*. Published February 20, 2025; 103052.
- Ko YK, *Kagaya W*, Yoneoka D, Kongere J, Opiyo V, Oginga J, Omondi P, Musyoka KB, Chan CW, Kanoi BN, Gitaka J, Kaneko A. Where is the hard-to-reach population? Spatial analysis from a cross-sectional study on the access to bed net and malaria vaccine in the Lake Victoria Region, Kenya. *Malar J*. 2025 Feb 12; 24(1): 42.
- Ko YK, *Kagaya W*, Omondi P, Musyoka KB, Okai T, Chan CW, Kongere J, Opiyo V, Oginga J, Mungai S, Kanoi BN, Kanamori M, Yoneoka D, Keitany KK, Songok E, Okomo GO, Minakawa N, Gitaka J, Kaneko A. Evaluation of the protective efficacy of OlysetPlus ceiling nets for reduction of malaria incidence in children in Homa Bay County, Kenya: a cluster-randomised controlled study protocol. *BMJ Open*. 2025 Jan 30.

2024

- Okai T, Chan CW, Kc A, Omondi P, Musyoka K, Kongere J, *Kagaya W*, Okomo G, Kanoi BN, Kido Y, Gitaka J, Kaneko A. *Plasmodium falciparum* with pfhrp2 and pfhrp3

gene deletions in asymptomatic malaria infections in the Lake Victoria region, Kenya. *Trop Med Health*. 2024 Dec 18; 52(1): 94.
- Ko YK, *Kagaya W*, Chan CW, Kanamori M, Mbugua SM, Rotich AK, Kanoi BN, Ngara M, Gitaka J, Kaneko A. Unraveling the 'community effects' of interventions against malaria endemicity: a systematic scoping review. *BMJ Public Health*. 2024 Dec 4; 2(2): e001557.
- Omondi P, Musyoka B, Okai T, Kongere J, *Kagaya W*, Chan CW, Ngara M, Kanoi BN, Kido Y, Gitaka J, Kaneko A. Non-random distribution of *Plasmodium* species infections and associated clinical features in children in the Lake Victoria region, Kenya, 2012–2018. *Trop Med Health*. 2024 Aug 5; 52(1): 52.
- Musyoka K, Chan CW, Gutiérrez Rico EM, Omondi P, Kijogi C, Okai T, Kongere J, Ngara M, *Kagaya W*, Kanoi BN, Hiratsuka M, Kido Y, Gitaka J, Kaneko A. Genetic variation present in the CYP3A4 gene in Ni-Vanuatu and Kenyan populations in malaria endemicity. *Drug Metab Pharmacokinet*. 2024 Jul 10; 57: 101029.
- Sekine S, Chan CW, Kalkoa M, Yamar S, Iata H, Taleo G, Kc A, *Kagaya W*, Kido Y, Kaneko A. Tracing the origins of *Plasmodium vivax* resurgence after malaria elimination on Aneityum Island in Vanuatu. *Commun Med*. 2024 May 18; 4(1): 91.
- Matsumoto T, Nagashima M, *Kagaya W*, Kongere J, Gitaka J, Kaneko A. Evaluation of a financial incentive intervention on malaria prevalence among the residents in Lake Victoria basin, Kenya: study protocol for a cluster-randomized controlled trial. *Trials*. 2024 Mar 4; 25(1).

2023

- Osborne A, Phelan JE, Kaneko A, *Kagaya W*, Chan C, Ngara M, Kongere J, Kita K, Gitaka J, Campino S, Clark TG. Drug resistance profiling of asymptomatic and low-density *Plasmodium falciparum* malaria infections on Ngodhe Island, Kenya, using custom dual-indexing next-generation sequencing. *Sci Rep*. 2023 Jul 14; 13(1): 11416.
- *Kagaya W*, Chan CW, Kongere J, Kanoi BN, Ngara M, Omondi P, Osborne A, Barbieri L, Kc A, Minakawa N, Gitaka J, Kaneko A. Evaluation of the protective efficacy of Olyset®Plus ceiling net on reducing malaria prevalence in children in Lake Victoria Basin, Kenya: study protocol for a cluster-randomized controlled trial. *Trials*. 2023 May 25; 24(1): 354.

2022

- *Kagaya W*, Takehara I, Kurihara K, Maina M, Chan CW, Okomo G, Kongere J, Gitaka J, Kaneko A. Potential application of the haematology analyser XN-31 prototype for field malaria surveillance in Kenya. *Malar J*. 2022 Sep 1; 21(1): 252.

2021

- Osborne A, Manko E, Takeda M, Kaneko A, *Kagaya W*, Chan C, Ngara M, Kongere J, Kita K, Campino S, Kaneko O, Gitaka J, Clark TG. Characterizing the genomic variation and population dynamics of *Plasmodium falciparum* malaria parasites in and around Lake Victoria, Kenya. *Sci Rep*. 2021 Oct 6; 11(1): 19809.
- Miyazaki S, Chitama BYA, *Kagaya W*, Lucky AB, Zhu X, Yahata K, Morita M, Takashima E, Tsuboi T, Kaneko O. *Plasmodium falciparum* SURFIN4.1 forms an intermediate complex with PTEX components and Pf113 during export to the red blood cell. *Parasitol Int*. 2021 Aug 21; 83: 102358.

[International Conference, Symposium, and Invited speakers]

- Akira Kaneko, An integrated community-directed strategy for sustainable freedom from malaria in Kenya. TICAD9 side event, Yokohama, 21 August 2025
- Akira Kaneko, Insecticide-treated ceiling nets to combat partial artemisinin resistant malaria in tropical Africa. 21st International Congress for Tropical Medicine & Malaria, Kuching, Malaysia, 22 September 2024
- Wataru Kagaya, Olyset®Plus ceiling nets protect against malaria: Findings from a cluster randomized controlled trial of the effectiveness of Olyset®Plus ceiling net on reducing malaria prevalence and incidence on Mfangano Island, Lake Victoria basin, Kenya. American Society of Tropical Medicine and Hygiene 2024 Annual Meeting – November 15, 2024
- Wataru Kagaya, Insights from observational and interventional studies on malaria in the Lake Victoria Basin of Kenya. 93rd Annual Meeting of the Japanese Society of Parasitology – March 10, 2024
- Tomoya Matsumoto, An economic intervention for anti-malarial behavior among the residents in Lake Victoria basin, Kenya. Joint Global Health Conference 2023 – November 24, 2023
- Tomoya Matsumoto, Experimental intervention for behavioral change for malaria elimination. Water Symbiosis Malaria Workshop – November 4, 2023
- Tomoya Matsumoto, Economic aspects of malaria control/elimination
- Africa International Biotechnology and Biomedical Conference workshop – 30 October 2023
- Tomoya Matsumoto, Economic intervention for behavioral change for malaria elimination
- Africa symposium: Acceleration of the malaria elimination in tropical Africa: the post–COVID–19 pandemic challenges – December 1, 2022
- Akira Kaneko, An integrated community-directed strategy for sustainable freedom from malaria in Kenya, TICAD8 Side Event: NTDs and Malaria Countermeasures in the With-COVID Era – Considering the Construction of Healthcare Infrastructure, Online, September 29, 2022
- Akira Kaneko, Zero Malaria Strategy: A Community-Directed Integrated Approach from Vanuatu to Kenya, Tokyo, June 15, 2022
- Akira Kaneko, Interdisciplinary Research Project for a Community-Directed Integrated Strategy Toward a Sustainable Malaria-Free Society, Nikkei–FT Infectious

Diseases Conference, Online, July 28, 2022
- Akira Kaneko, Special Lecture: Malaria Eradication on Islands, 77th Annual Meeting of the Western Japan Branch of the Japanese Society of Parasitology, Online, September 22, 2022
- Tomoya Matsumoto, Economists' Approaches to Public Health and Malaria Control. Africa International Biotechnology and Biomedical Conference workshop – 8 November 2021
- Akira Kaneko, Africa Task Force, Nikkei–FT Infectious Diseases Conference, Tokyo, October 28, 2021

[Oral Presentations]
- Brian Musyoka, Genetic and functional variations in glucose 6-phosphate dehydrogenase in the malaria-endemic Lake Victoria basin in Kenya. Japanese Society of Parasitology Meeting, Osaka – March 18, 2025
- Hanako Iwashita, A Study on the Effectiveness of Long-Lasting Insecticidal Nets Considering Socio-Economic Status: A Cross-Sectional Study in the Lake Victoria Basin, Western Kenya. Joint Global Health Conference 2024, Okinawa – November 16, 2024
- Wataru Kagaya, Malaria Transmission and Countermeasures in the Lake Victoria Basin of Kenya. 2nd Webinar of "Anthropology of Infectious Diseases" – January 12, 2024
- Wataru Kagaya, Evaluation of the protective efficacy of Olyset®Plus ceiling net on reducing malaria prevalence in children in Lake Victoria basin, Kenya. Joint Global Health Conference 2023 – November 24, 2023
- Wataru Kagaya, Evaluation of the protective efficacy of Olyset®Plus ceiling net in Lake Victoria basin, Kenya. Africa International Biotechnology and Biomedical Conference – October 30, 2023
- Hanako Iwashita, Reconsidering the Effectiveness of Insecticide-Treated Nets on the Shores of Lake Victoria, Kenya. 63rd Annual Meeting of the Japanese Society of Tropical Medicine, Oita – October 8, 2022

4. Future Challenges, Prospects, and Recommendations

We recently highlighted the urgent need for countermeasures against artemisinin resistance in *Science* [Dhorda M, Kaneko A et al. 2024]. The strategy outlined therein centers on a multifaceted approach involving international cooperation and community-led efforts to achieve permanent malaria control.

Recently, the first malaria vaccines in history, RTS/S and R21, have finally been introduced in Africa, and their rollout is progressing in target areas. Both vaccines target sporozoites, which are transmitted to humans by mosquito vectors. However, there is no "magic bullet" for malaria. Past experience demonstrates the necessity of multifaceted interventions targeting the malaria parasite life cycle to achieve eradication.

We propose an integrated malaria elimination strategy that combines the newly identified Olyset®Plus ceiling nets with interventions such as vaccines and

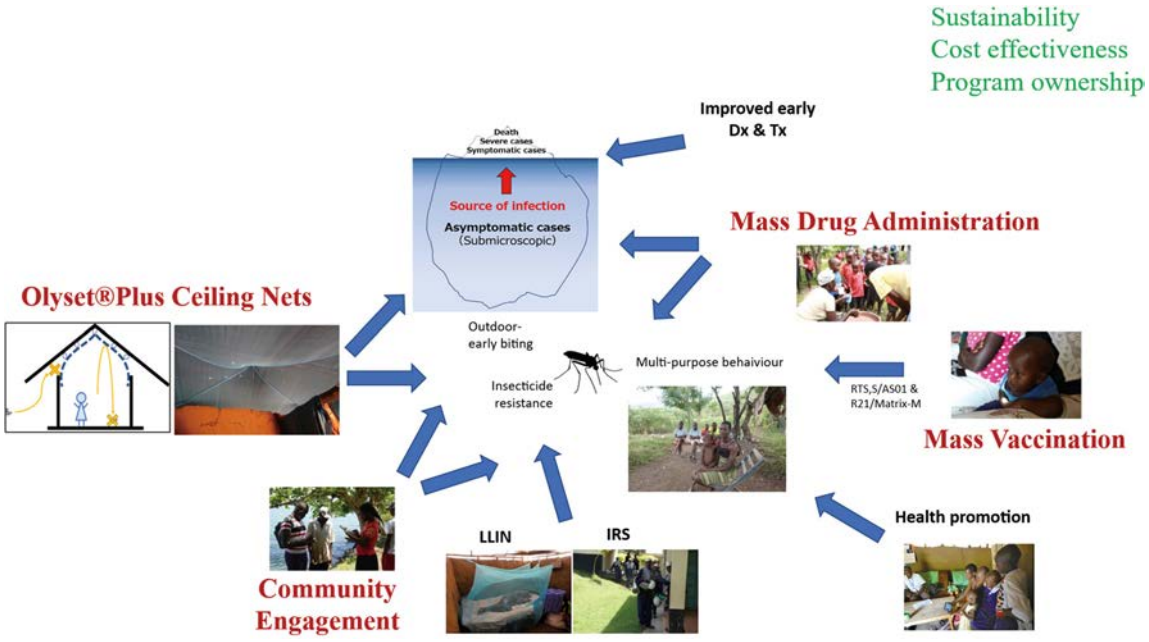


Fig. 5 A community-directed multi-pronged approach to reduce and interrupt malaria transmission in Africa permanently

treatments, while ensuring strong community participation. The keys to success are sustainability, cost-effectiveness, and program ownership. We believe that this strategy, when implemented in the Great Lakes region, which is at the epicenter of malaria epidemics, will accelerate malaria eradication in tropical Africa.

References

Attaran A, Barnes KI, Curtis C, et al. WHO, the Global Fund, and medical malpractice in malaria treatment. *Lancet* 2004; 363(9404): 237-40.

Björkman Nyqvist, Martina, Lucia Corno, Damien de Walque, and Jakob Svensson. 2018. "Incentivizing Safer Sexual Behavior: Evidence from a Lottery Experiment on HIV Prevention." *American Economic Journal: Applied Economics* 10(3): 287-314. DOI: 10.1257/app.20160469

Dhorda M, Kaneko A, Komatsu R, Kc A, Mshamu S, Gesase S, Kapologwe N, Assefa A, Opigo J, Adoke Y, Ebong C, Karema C, Uwimana A, Mangara JN, Amaratunga C, Peto TJ, Tripura R, Callery JJ, Adhikari B, Mukaka M, Cheah PY, Mutesa L, Day NPJ, Barnes KI, Dondorp A, Rosenthal PJ, White NJ, von Seidlein L. Artemisinin-resistant malaria in Africa demands urgent action. *Science*. 2024 Jul 19; 385(6706): 252-254. doi: 10.1126/science.adp5137.

Henley D. Asia-Africa development divergence: A question of intent. Zed Books: London. 2015.

Idris ZM, Chan CW, Kongere J, Hall T, Logedi J, Gitaka J, Drakeley C, Kaneko A. Naturally acquired antibody response to Plasmodium falciparum describes heterogeneity in transmission on islands in Lake Victoria. Sci Rep. 2017; 7(1): 9123.

Idris ZM, Chan CW, Kongere J, Gitaka J, Logedi J, Omar A, Obonyo C, Machini BK, Isozumi R, Teramoto I, et al. High and heterogeneous prevalence of asymptomatic and sub-microscopic malaria infections on islands in Lake Victoria, Kenya. Sci Rep. 2016; 6(1): 36958.

Kagaya W, Chan CW, Kongere J, Kanoi BN, Ngara M, Omondi P, Osborne A, Barbieri L, Kc A, Minakawa N, et al. Evaluation of the protective efficacy of Olyset®Plus ceiling net on reducing malaria prevalence in children in Lake Victoria Basin, Kenya: study protocol for a cluster-randomized controlled trial. Trials. 2023; 24(1): 354.

Ko YK, Kagaya W, Omondi P, Musyoka KB, Okai T, Chan CW, Kongere J, Opiyo V, Oginga J, Mungai S, et al. Evaluation of the protective efficacy of OlysetPlus ceiling nets for reduction of malaria incidence in children in Homa Bay County, Kenya: a cluster-randomised controlled study protocol. BMJ Open. 2025; 15(1): e087832.

Matsumoto T, Nagashima M, Kagaya W, Kongere J, Gitaka J, Kaneko A. Evaluation of a financial incentive intervention on malaria prevalence among the residents in Lake Victoria basin, Kenya: study protocol for a cluster-randomized controlled trial. Trials. 2024; 25(1): 165.

Minakawa N, Kongere JO, Sonye GO, Lutiali PA, Awuor B, Kawada H, Isozumi R, Futami K. Long-Lasting Insecticidal Nets Incorporating Piperonyl Butoxide Reduce the Risk of Malaria in Children in Western Kenya: A Cluster Randomized Controlled Trial. Am J Trop Med Hyg. 2021 Jun 14; 105(2): 461-471. doi: 10.4269/ajtmh.20-1069.

Murray CJ, Rosenfeld LC, Lim SS, Andrews KG, Foreman KJ, Haring D, Fullman N, Naghavi M, Lozano R, Lopez AD. Global malaria mortality between 1980 and 2010: a systematic analysis. Lancet. 2012 Feb 4; 379(9814): 413-31. doi: 10.1016/S0140-6736(12)60034-8.

Ntoumi F. What if tropical diseases had as much attention as COVID? Nature. 2020 Nov; 587(7834): 331. doi: 10.1038/d41586-020-03220-5.

Sachs J, Malaney P. The economic and social burden of malaria. Nature. 2002 Feb 7; 415(6872): 680-5. doi: 10.1038/415680a. PMID: 11832956.

Stokes BH, Ward KE, Fidock DA. Evidence of Artemisinin-Resistant Malaria in Africa. N Engl J Med. 2022 Apr 7; 386(14): 1385-1386. doi: 10.1056/NEJMc2117480.

Symons TL, Lubinda J, McPhail M, Saddler A, van den Berg M, Baggen H, Berman Y, Hafsia S, Jayaseelen R, Amratia P, Browne A, Cameron E, Vargas-Ruiz C, Rumisha SF, Golding N, Weiss DJ, Gething PW. Estimating the potential malaria morbidity and mortality avertable by the US President's Malaria Initiative in 2025: a geospatial modeling analysis. Lancet. 2025 Jun 21; 405(10496): 2231-2240. doi: 10.1016/S0140-6736(25)00805-0.

Covid-19 and Society: Comparative Analysis of Risk Communication, Expertise, and Citizenship

Grant Period: from December 1, 2021 through November 30, 2024
Grant Amount: 30 million yen
Principal Researcher: Mikihito Tanaka
Professor, Faculty of Political Science and Economics, Waseda University

This project compared global social responses to COVID-19, particularly focusing on Japan, based on the insights from the humanities and social sciences. Specifically, it examined (1) the actual state and effects of risk communication in mass/social media, (2) science and technology studies-based issues of production and expert knowledge use, and (3) public understanding and responses to risks and expert knowledge. Through this research project, we gained insights into the effectiveness of risk responses implemented during the pandemic, identified Japan's unique characteristics through international comparisons, and derived implications for building a more resilient society in the face of future crises.

1. Research Reports

This project addressed multiple issues through sub-projects, employing various methodologies. Therefore, the following studies will be explained using distinct headings: "2. Research Objectives," "3. Research Methods and Progress," and "4. Research Achievements."

1.1 Japanese Perspectives Regarding Science and COVID-19

1.1.1 Research Objectives

Though the COVID-19 pandemic threatened the entire world, scientific knowledge to address it was also rapidly shared globally. Despite this, responses varied across countries. These differences were influenced by various factors, such as politics, economics, history, culture, and social systems, demonstrating that scientific knowledge alone could not determine a single "correct" response. This also highlights the need for the Japanese society to understand its position relative to international trends and prepare for future pandemics.

Hence, this research project conducted three surveys. The first survey was an international comparative study on COVID-19 risk perception (Ishibashi, Sekiya, & Tanaka, 2024). The second survey was a part of a global survey project on trust in science, including COVID-19 (Cologna et al., 2025; Mede et al., 2025). The third survey examined the Japanese public's view of science and, by extension, their view of COVID-19.

1.1.2 Research Methods and Progress

The first survey, aimed at understanding risk perceptions during the COVID-19 pandemic, was conducted online in February and March 2021 in ten countries (Japan, South Korea, Singapore, the UK, the US, Taiwan, China, Germany, Sweden, and Italy) (sample was gender- and age-balanced, n = 3,300, including 600 from Japan).

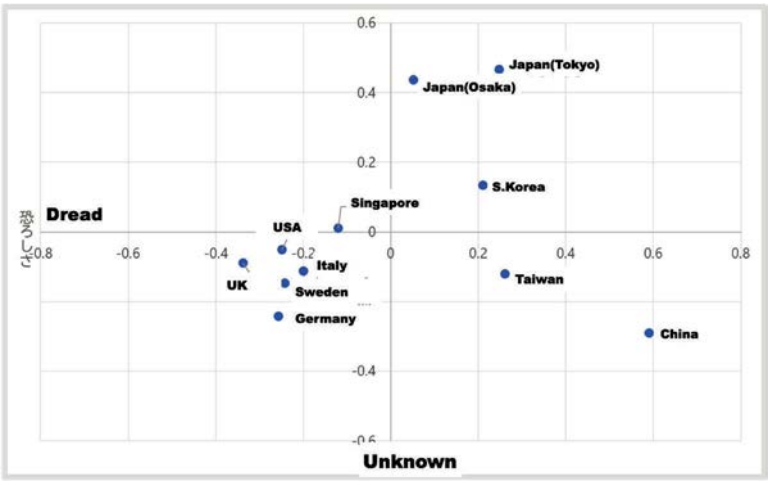
A subsequent large-scale survey was conducted in collaboration with researchers from around the world, including those from the University of Zürich and Harvard University, targeting 71,922 people in 68 countries to analyze online surveys regarding trends in scientific populism.

Building on the above, the third survey was conducted in February 2025, targeting 12,000 participants to gain insights into Japan's unique characteristics.

1.1.3 Research Achievements

Previous studies have shown that risk perception can be understood in terms of two factors: the "dread" and "unknown" tendencies associated with the perceived

(A)



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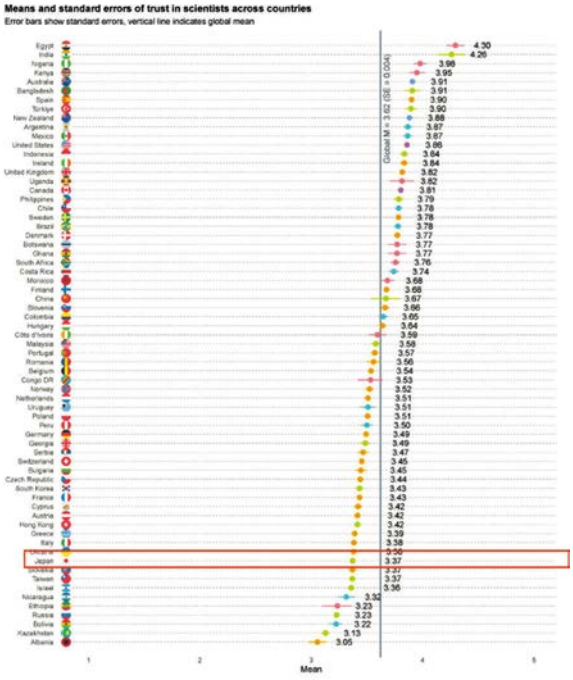

Fig. 1 A) Plot of risk perceptions in the 10 countries surveyed, based on dread (horizontal axis) and unknown (vertical axis). B) Level of trust in science in the 68 countries surveyed.

risk. The results of the first survey revealed two distinctive features of the Japanese society in international comparison: (1) high levels of risk perception and anxiety in terms of both dread and the unknown, and (2) high trust in medical professionals and low trust in the media (Fig. 1A).

The results of the second survey showed that while trust in science was high globally, it was significantly lower in Japan than the global average (Fig. 1B); distrust in science, including COVID-19, was high at both ends of the ideological spectrum.

The third survey revealed that Japanese people's trust in science shows little partisan bias, and that the commonly cited distinction between "liberal arts" and "science" has almost no correlation with trust in science or COVID-19 countermeasures.

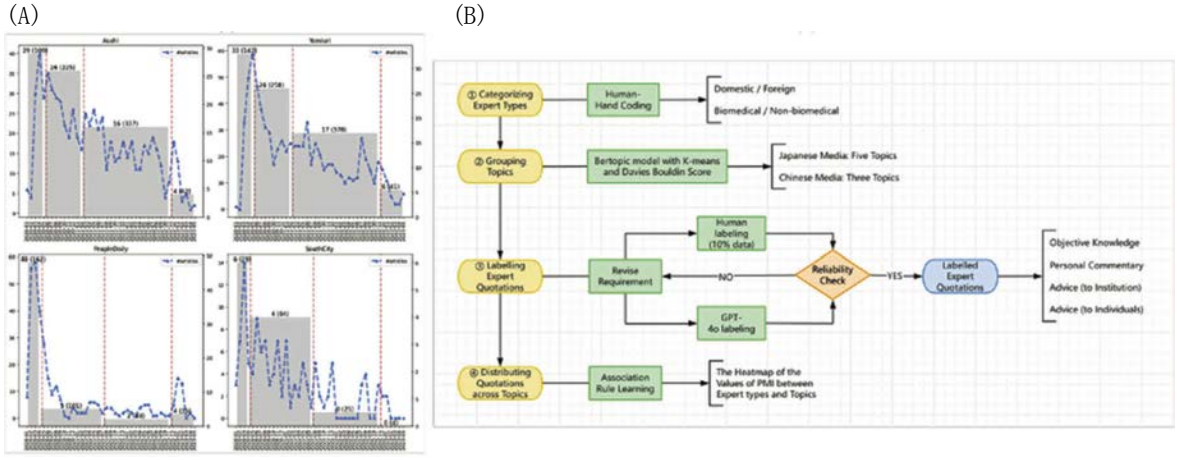

Fig. 2 (A) The number of target data in each stage and their changes over time; (B) Four steps of analysis.

1.2 Roles of Scientific Experts in COVID-19 News Coverage: A Comparative Study Between Japan and China

1.2.1 Research Objectives

Experts framed the pandemic; meanwhile, they were framed by the pandemic as well. During the COVID-19 pandemic, experts were presented to the public by the media more than ever before. Newsroom and dominant political culture of the society shape different media representations of experts, which makes a cross-country comparison meaningful. This study compared Japan and China for their differences and similarities in pandemic policies and general views on science, while exploring the roles of experts in media coverage.

1.2.2 Research Methods and Progress

This study analyzed the direct quotes of scientific experts because of their capability to characterize the person being quoted and serve as an indicator of expert roles in media texts. It collected COVID-19-related news from 2020 to 2023 from four representative newspapers in China and Japan (Fig. 2A). The extracted direct quotes were analyzed in three main steps: categorizing expert types, grouping topics, and labeling expert quotes (see Fig. 2B).

1.2.3 Research Achievements

In both China and Japan, experts' words were quoted to explain the research findings on infection, vaccine, or medicine development; to assess the effects of countermeasures, vaccination, and prediction of infection status; and to advise citizens about self-protection. In contrast to Japan, where experts' tones were usually mixed with both negative and positive affect, in China, they were generally positive. In Japan, both complimentary or critical comments were infrequent, whereas in China, where experts often act as cheerleaders applauding achievements, expert compliments on China's control measures were surprisingly uncommon.

To summarize, experts in Japan proactively provided multiple options to the government, while the government passively made the final decisions. However, for agenda-setting, the media presented experts as proactive advocates who led the discussions with restrained criticism, which led to an inaccurate image that experts accounted for policy-making decisions. In contrast, experts in China were tightly embedded in the emergency policymaking system, practically wielding great influence, but the media made them appear "only focusing on science," for propaganda and to enhance legitimacy, akin to the stealth issue-advocating pattern that expert always brought good news to enhance the legitimacy of government's policy.

The patterns of experts' quotes reveal not only Authorial decisions, but also deeper societal structures that determine who can speak and what can be communicated in a health crisis. The missing voices and boundaries between scientific and social-scientific expertise in media coverage should be further discussed in the backdrop of social backgrounds of these two societies toward a deeper understanding of the relational leverage social actors have in legitimizing scientific knowledge.

1.3 Expert Communication of COVID-19 Information and Public Sentiment on Social Media: A Comparative Study of Japan and China

1.3.1 Research Objectives

This study aimed to elucidate the characteristics of COVID-19-related information dissemination by experts on social media in Japan and China, and empirically identify similarities and differences in expert-led risk communication under distinct political regimes and social structures through a cross-national comparison. In high-uncertainty situations such as infectious disease outbreaks, experts play a pivotal role in analyzing and interpreting provisional scientific knowledge and recommending risk mitigation measures. Accordingly, expert communication is essential for overcoming social crises, and has become a focal point on social media platforms. This study investigated how experts in Japan and China—countries with markedly different political systems and sources of social authority—communicated COVID-19-related information, and how their communication elicited public responses online.

1.3.2 Research Methods and Progress

This study analyzed approximately 300,000 Weibo posts from China (from January 1 to March 27, 2020) and approximately 300,000 posts from Japan's Twitter (now X) platform (from January 23 to May 25, 2020). We chose the period of the Wuhan lockdown and Japan's first COVID-19 wave, both of which were characterized by high uncertainty in the case study. Semi-supervised machine learning methods, specifically seeded latent Dirichlet allocation (seeded LDA) and latent semantic scaling (LSS), were employed to extract prominent topics and quantitatively assess emotional and discursive features. The analysis focused on: (1) the thematic evolution of experts; (2) changes in indicators of anxiety, fear, and incivility; (3) the relationship between these discursive features and concrete risk response measures; and (4) the characteristics of expert communication in the Japanese context.

1.3.3 Research Achievements

The analysis revealed several findings common to both countries. Before government policies were clearly articulated, there was an observable increase in discourse concerning government responsibility and a surge in uncivil expressions. Discussions that invoked fear and anxiety peaked during periods of increased uncertainty. However, political regime differences significantly shaped the discourse of experts. In China, government's criticism was markedly lower, and dominant narratives emphasized "overcoming hardship" through the use of war metaphors. In contrast, Japanese discourse tended to center on "difficulty" without resorting extensively to such metaphors. Expert communication in Japan was generally calm and neutral, and—except in the case of the Diamond Princess incident—appeared to play a role in suppressing public anxiety and promoting cooperative behavior. Nevertheless, in the period preceding the state of emergency declaration, uncivil expressions targeting individual experts were particularly prevalent. These findings suggest that political and

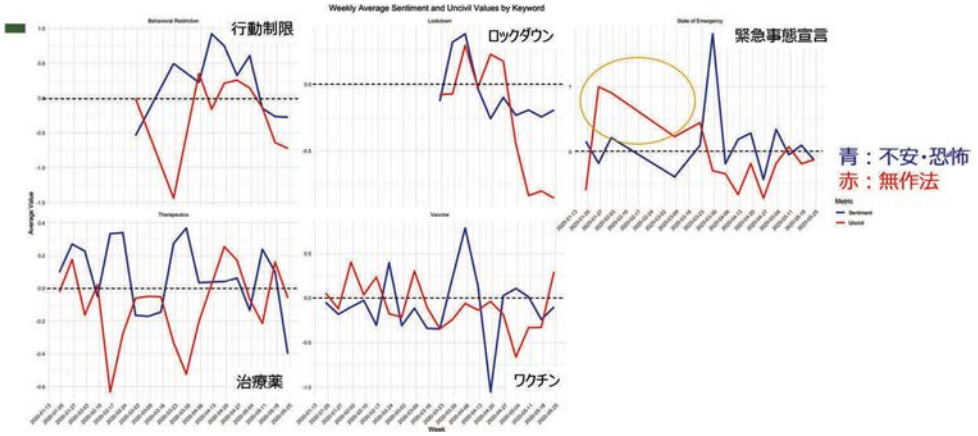

Fig. 3. Partial Results: Relationship between COVID-19 Countermeasures and "Anxiety/Fear" and "Incivility"

social structures influence the nature and dynamics of risk communication on social media platforms. Moving forward, it will be necessary to refine the analytical design by expanding the range of comparative cases and examples.

1.4 How Should Risk be Communicated Online?

1.4.1 Research Objectives

In today's media environment, it is impossible to ignore the influence of online media, especially social media, on citizens' understanding of risks. This project analyzed big data collected mainly from discussions related to COVID-19 from various perspectives to understand how citizens shared information and responded to information disseminated by experts and mass media during the pandemic.

1.4.2 Research Methods and Progress

The data used for analysis were obtained from Application Programming Interfaces (APIs) such as Twitter (now X), where available. For sources such as Wikipedia and Yahoo! comment sections, we created our own Python programs to collect the data. We attempted to gain comprehensive insights by applying quantitative analysis methods such as statistical processing and machine learning, as well as qualitative methods such as discourse analysis, to this big data.

1.4.3 Research Achievements

Many topics related to the COVID-19 pandemic became central topics of discussion on social media. Analysis of these topics yielded several insights. For example, during the early stages of the pandemic, there was extensive debate on social media regarding "PCR (polymerase chain reaction) testing." While the notion that the government was intentionally suppressing testing ("testing suppression theory") was strongly supported by a small group, much of the discussion relied on the framing of larger online media outlets (Tanaka et al., 2022).

There were also cases in which collaboration between social media and mass media, as well as the knowledge of experts and expert groups, helped correct misinformation. When new variants of the novel coronavirus began to emerge, the term "mutant strain" initially became widespread, but this was corrected by experts on social media, followed by mass media outlets such as television stations revising their terminology in response to statements from academic societies, leading to a correction in the terminology used in the media (Lim et al. 2024; Fig. 4A).

What effect does structural refuting of misinformation have in correcting misinformation? We conducted an analysis of a rumor circulating on social media claiming that "the COVID-19 vaccine causes infertility." After public broadcasters and major newspapers extensively reported the analysis results, stating that "the rumor on Twitter that the vaccine causes infertility is being amplified by a small number of agitators," we compared and analyzed the discussion on Twitter before and after the reports. The results indicated that, while some information correction effects were recognized, they remained within reversible limits (Fig. 4B; paper in preparation). Additionally, the data from this study revealed that scientific discussions in Japan have a different partisan structure than those in countries such as the United States.

Furthermore, experts who shared medical and scientific information about COVID-19 faced intense criticism in Japan, similar to other countries around the world (Tanaka, Hana, Yu, & Yoshida, 2024). An analysis of the responses (replies) from citizens to 14 experts who continuously shared information on Twitter (X) revealed that, contrary to prior expectations, the responses were not necessarily extreme criticism (Yao, Yoshida, & Tanaka, 2024), suggesting that experts sharing information on social media may be troubled by the visibility of the intense criticism amplified by algorithms.

Are there any examples in which a skeptical attitude toward science changed through dialogue? We analyzed 100,000 Twitter discussions on the HPV vaccine collected over more than a decade. We observed that between 2014 and 2017, the atmosphere shifted toward vaccine acceptance as people maintained a scientific attitude while engaging in sincere dialogue (Han, Yoshida, & Tanaka, 2024). We are currently conducting a more detailed analysis of these findings (manuscript in preparation).

In the midst of a pandemic of high scientific uncertainty, the challenge lies in building reliable information. Wikipedia has continued to build high-quality information on COVID-19 through the efforts of citizen users; we analyzed what types of people contributed to this. We found that many articles were initially

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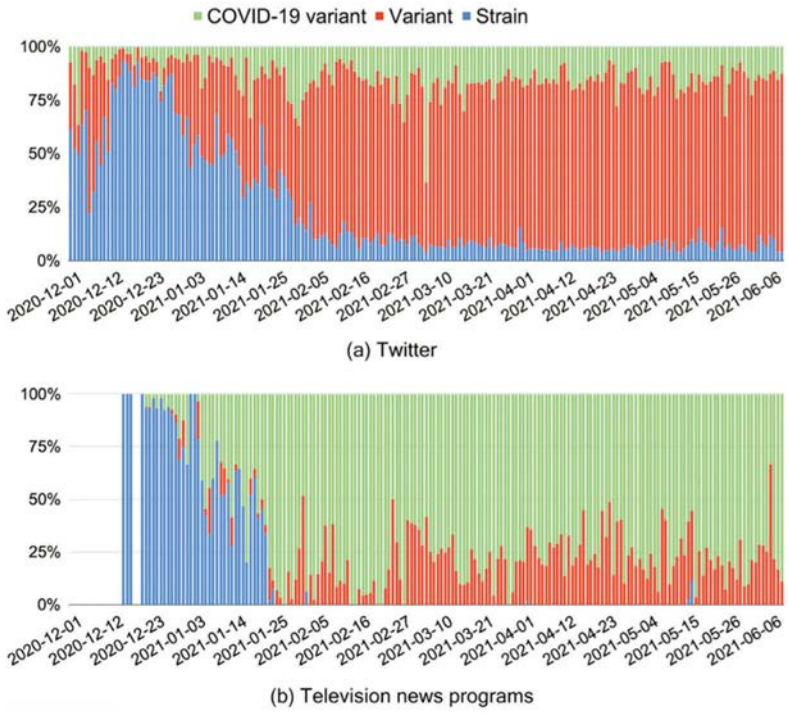

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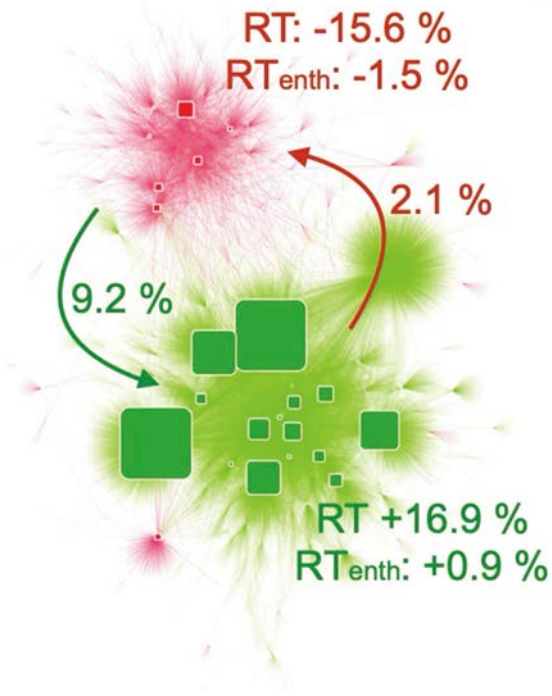

Fig. 4 A) Time-series changes in the frequency of use of "variant (red)" and "strain (blue)" in Twitter (a) and television news (b). B) Twitter discussion's network diagram after news reports that a rumor claiming COVID-19 vaccination causes infertility was spread by a small number of agitators, and changes in user movement trends and activity compared to before the reports. Green indicates vaccine proponents whereas red indicates vaccine skeptics.

structured by Authors who typically prefer to write articles on "politics and society," followed by Authors who prefer articles on "medicine and science," ensuring the scientific accuracy of the details (Yang & Tanaka, 2023).

These findings not only describe the confusion surrounding online media discussions about COVID-19, but also offer insights into how to address it, making them highly valuable for future research and risk communication practices.

1.5 Representations of Science/Experts in Political Satire Manga

1.5.1 Research Objectives

During the COVID-19 pandemic, several experts disseminated their expertise through various media outlets. While the efficacy of visual narratives and collaboration between medical experts and comic artists in risk communication and health literacy has been acknowledged (Jarreau et al., 2021), it is crucial to consider the lay public's understanding and expertise, to investigate "cultural/hermeneutic character of scientific knowledge itself" (Wynne, 1998) in particular. Manga (Japanese comics) is not only a medium for experts to educate the public (Berndt, 2017), but also a popular one for the public to express their interpretations and experiences of technoscientific disasters (Abe, 2017), and therefore a rich venue for capturing the socio-technical imaginary (Jasanoff and Kim, 2015). This study analyzed public engagement with science through COVID-19-themed political satire manga essays, specifically focusing on how experts and expert knowledge have been represented among the general public.

1.5.2 Research Methods and Progress

This study examined two political satire manga essays published between 2020 and 2021 that were critical of the Japanese government's COVID-19 response, specifically from both liberal and conservative perspectives: Bōgo Natsuko's COVID Pandemic that Does Not End in 100 Days and Kobayashi Yoshinori's Declaration of Arrogantism Special COVID Edition 3. This study examined the representation of science, specialized knowledge, and experts in these manga. MaxQDA was used for coding, based on the literature and inductive analysis. The codes used in this study were "experts," "science," and "facts." These were coded respectively for mentions of experts, mentions of science or scientific knowledge, and mentions that included claims that something is (or is not) a fact.

1.5.3 Research Achievements

Due to differences in screen composition and total word count, Kobayashi's work had more coded sections: Bōgo's total coded segments were 288, Kobayashi's were 835. However, Bōgo's codes for "experts" and "science" were nearly equal in number ("experts": 29, "science": 27). In contrast, Kobayashi's work had a significantly higher number of "science" codes (90), followed by "facts" (66). A common feature of both works was the frequent emphasis on their own claims being "scientific," while being anti-establishment and negative about the government and specific experts. Both shared content that visually explained scientific mechanisms, similar to the style of educational manga, and explanations on how to "read data correctly." In other words, while being anti-establishment and critical of the government, their criticism was based on "science" and "logic" (which they consider correct), and emphasized the "irrationality" of the government and specific experts.

However, there were differences in how "science" and "logic" were expressed. Bōgo summarized news reports of expert and politician statements into concise, single-panel illustrations with quoted content, and expressed rebuttals with the same simplicity in handwritten statements. In contrast, Kobayashi's work featured explanations and quotes from news reports, and his own rebuttals spanned multiple panels, with expert statements and Kobayashi's statements appearing alternately. This difference suggests that Bōgo expressed the premise that (correct) logic is shared without "long explanations" and "can be understood in a word," representing the expectation of "gaining sympathy without saying much" from the main readership. Contrarily, Kobayashi emphasized that his logic was "understood as correct by anyone who reads it" by "carefully explaining why his rebuttal is correct and the expert's statement is wrong."

Moreover, the basis of distrust in the experts differed. For Bōgo, experts appointed by the government were themselves untrustworthy, and it was inappropriate for experts in specific fields to be asked for opinions or knowledge in fields outside their expertise.

Therefore, Bōgo did not harbor distrust in "experts" themselves. In contrast, Kobayashi argued that "experts" and "specialized knowledge" themselves were siloed; they could see matters in other fields, and their scientific knowledge became "wrong" in Kobayashi's "comprehensive" context. Therefore, the basis of distrust was the very nature of "experts." For Kobayashi, trustworthy experts are individuals with "comprehensive knowledge" who ultimately become themselves or those who agree with his interpretations.

Bōgo and Kobayashi's interpretations of "experts" and "specialized knowledge" visually explained how various controversies (masks, PCR, vaccines, etc.) were emotionally understood by the general public, and showed the diversity of strategies, assumptions, and logical appeals in those controversies. International comparative surveys have reported that experts were relatively trusted in Japan (Ishibashi, Tanaka, and Sekiya, 2021), but clear objections were being raised in peripheral media such as political satirical manga. However, it is characteristic that even in these objections, the aspect of seeking "scientification," as Sugawara (2022) calls it, can be seen, and trust in "science" did not waver.

1.6 Challenges of Expertise in COVID-19 Governance: Scientism, Politics, and Media Ecology in Japan

1.6.1 Research Objectives

Prior to this project, Tanaka, Juraku, and Sato participated in an international research project, *Comparative COVID Response: Crisis, Knowledge, Policy* (CompCoRe), organized by Sheila Jasanoff (Harvard University) and Stephen Hilgartner (Cornell University), prominent scholars in the field of Science and Technology Studies (STS). The CompCoRe's interim report (Jasanoff et al. 2021) contended that one key question regarding the crisis-time interplay of science, technology, and society is: "What makes expert knowledge credible, legitimate, and trustworthy in its use in public policy?" At the heart of this question is the concept of the *social compact* – specifically its function, role and the need to update our understanding of it. This concept is akin to what is generally understood in Japan as *social contract*, which, as described in the report, has classically been considered to address the relationship between citizens or between citizens and the state. However, Jasanoff et al. (2021) argued that in the 21st century, this conventional understanding needs to be revised with the awareness that *epistemic authority* has become a critical issue, aligning with long-standing STS perspectives on the interplay among science, technology, and society.

We sought to apply these insights to post-pandemic Japan, evaluate their validity, and gain a new understanding of their academic and social relevance. By collecting both qualitative and quantitative data, we empirically explored how experts and expertise were positioned in Japan's crisis response and policymaking processes, what the public expected from them, what gaps existed between such expectations, and how experts navigated the evolving circumstances.

1.6.2 Research Methods and Progress

This study examined various prevailing views and assumptions regarding the interaction between expert knowledge, politics, and policymaking by tracing several key debates related to the pandemic governance in mass media coverage, in-depth interview data, and public documents and publications. In our analysis of major domestic newspapers published between early 2020 (when the pandemic began) and 2022, we used topic modeling to identify articles that discussed the following topics: (1) border control measures, (2) PCR testing, (3) "airborne transmission," (4) medicine and healthcare, (5) discrimination, (6) citizens and civil society, and (7) expertise. We then analyzed the content of these articles. Simultaneously, we conducted interviews with experts involved in policy advisory positions during the pandemic crisis to illuminate commonalities and differences in the individual understandings of those with diverse positionalities and areas of expertise.

1.6.3 Research Achievements

Our analysis shows that the opposing views vis-à-vis the seven key issues mentioned above often shared common underlying views, such as strong scientism, technological solutionism, essentialism regarding technoscience, and ideas of the public anchored in a "deficit model." During the pandemic, the assumption that politics and societal values could and should be separated from expert knowledge and technoscience, became even more pronounced and entrenched. This, in turn, likely thwarted meaningful public discussions on the types of expertise that were most relevant, poli-

tics of expertise, and social values to be prioritized.

These findings point to the characteristics of Japan's *social compact* regarding scientific advice and that they can serve as powerful obstacles to rethinking or renewing our ideas of *epistemic authority* – a particularly important aspect of social compact in the 21st century. In other words, Japan's *social compact* concerning scientific advice tends to resist self-reflection, or attempts to critically assess how such advice should work. Resonating with the concept of "structural disaster" (*kōzōsai*) in the sociology of science (Matsumoto 2002-2012; 2009; 2012), this suggests a system that repeatedly fails in the similar manner and continues to harm the public good.

Notably, even parts of the Japanese STS community—a discipline that has long advocated the critical examination of a societal system with the aim of finding ways to overcome its weaknesses and limitations—share the characteristics described above and constitute a part of Japan's robust social compact. More specifically, the so-called "stepping over" (*fumikoe*) debate, which presupposed the clear distinction between the domains of science and politics/public administration, gained traction in Japan's STS community. Some analyses emphasized the normative obligation of technical experts not to overstep the science-policy interface (e.g., Onai & Shirabe 2020; Hondo 2020; Yonemura 2020; see also overviews by Sadamatsu 2021 and Hirono 2022), while others have gone further to critically examine the substantive content of scientific advice against competing expert knowledge and propose alternatives (e.g., Hondo 2020, 2022).

While this sparked vigorous academic debate within the field, some important questions arose. For instance, who – or what – enabled advisory entities such as the Expert Meeting, Japan's central scientific advisory body for the pandemic governance, to "overstep" the boundaries of their expected roles? Certainly, the intentions and interactions of politicians, bureaucrats, and experts themselves played a role. However, from the theoretical perspective of the *social compact*, it is too simplistic to view these actions merely as unwanted or unacceptable overreach in the eyes of civil society and to attribute them to individual failures. More productive questions would be how broader societal expectations, such as the general tendency to try to base *science* itself as the authoritative basis rather than relying on expert advice (see Sugawara & Juraku 2018; Juraku & Sugawara 2021; Sugawara 2022), may have positioned and facilitated the epistemic authority, and whether such a mechanism led to this perceived "overstepping."

In preparing for future crises, it is vital, both academically and socially, not to limit our deliberations to superficial institutional reforms or the ethics of experts, but to bring a new level of awareness about more fundamental questions: What kinds of *epistemic authority* do we want as a civil society, and how should we update our *social compact*? We argue that this kind of critical reflection is crucial to breaking down and overcoming the persistent conditions of "structural disaster."

2. Main Publications and Conference Presentations

1. Cologna, V., Simona Meiler, Chahan M. Kropf, Samuel Lüthi, Niels G. Mede, David N. Bresch, Oscar Lecuona, Sebastian Berger, John Besley, et al.,（2025a）"Extreme weather event attribution predicts climate policy support across the world," *Nature Climate Change,* Vol. 15, 725-735.
2. Cologna,V., Niels G. Mede, Sebastian Berger, John Besley, Cameron Brick, Marina Jouber, Edward, W. Maibach, Sabina Mihelj, Naomi Oreskes, Miklihito Tanaka et al.,（2025b）"Trust in scientists and their role in society across 68 countries," *Nature Human Behaviour*, Vol. 9, 713-30.
3. Fu, M., Yang, K., & Tanaka, M.（2025 年 6 月 12 日）. The roles of scientific experts in COVID-19 news coverage: A comparative study between Japan and China. The 4th Science Communication Preconference at the 75th Annual Conference of the ICA, Denver, Colorado, United States.
4. 傅夢媛，楊鯤昊，田中幹人.（2024 年 11 月 30 日）. COVID-19 パンデミック報道における専門家の役割：日本と中国の比較. 科学技術社会論学会年次大会 2024，東京.
5. 石橋真帆，関谷直也，田中幹人「日本社会は COVID-19 というリスクをどのように捉えたのか？—調査票調査から」人工知能　39(3)374-380　2024 年 5 月
6. 寿楽浩太，佐藤恭子，田中幹人「岐路に立つ専門知と政治：日本の COVID-19 ガバナンスと今後の課題」科学技術社会論学会　2023 年 12 月 10 日
7. 寿楽浩太，田中幹人，佐藤恭子「COVID-19 パンデミックにおける各国社会の対応の比較分析：市民社会，リスク・コミュニケーション，専門知に着目して」科学技術社会論学会第 20 回年次研究大会 2021 年 12 月 5 日
8. Lim, D., Fujio Toriumi, Mitsuo Yoshida, Mikihito

Tanaka, Kunhao Yang,（2024）“The variant of efforts avoiding strain: Successful correction of a scientific discourse related to COVID-19,” Journal of Computational Social Science, 7, 1-21.
9. Lim, D., Haichun Yu, Mikihito Tanaka, Fujio Toriumi, “Science, Politics, or Somewhere in Between: Public Opinion on the Fukushima Nuclear Water Discharge in Japan, China, and Korea,” IAMCR Christchurch 2024 2024 年 7 月 4 日
10. Mede, N. G., Viktoria Cologna, Sebastian Berger John, Besley Cameron Brick Marina Jouber Edward, W. Maibach, Sabina Mihelj, Naomi Oreskes Mike, S. Schäfer, Sander van der Linden, Mikihito Tanala, et al.,（2025）“Perceptions of science, science communication, and climate change attitudes in 68 countries – the TISP dataset,” *Scientific Data* 12（114）.
11. 奈須野文槻，田中幹人，「科学の専門家助言における「あいまい」戦略の功罪」，人工知能　39(3)400-407　2024 年 5 月
12. 西村恵子．（2024 年 11 月 30 日）．専門家に対する不信感の根拠は何か：政治風刺マンガにおける科学・専門性の表象分析．第 23 回科学技術社会論学会 第 23 回年次研究大会，東京.
13. Nishimura, K.（2024, March 15）. “Representations of Experts, Credibility and Politics in Japan: Analysis of COVID-19-Themed Political Manga Essays.” Association for Asian Studies（AAS）2024 Annual Conference, Seattle, WA, USA.
14. Sato, K., Kohta Juraku, Mikihito Tanaka, “Expertise at a Crossroads: Challenges in Japan’s Covid-19 Governance and Beyond,” Society for Social Studies of Science 2023 年 11 月 10 日
15. Sato, K., Kohta Juraku, Mikihito Tanaka, “Covid-19, Public Mistrust, and Expertise in Japan: Diversifying Science Communication Strategies,” Society for Social Studies of Science Annual Meeting 2024, Amsterdam 2024 年 7 月 16 日
16. Sato, K., Kohta Juraku, Mikihito Tanaka, “Japan’s Covid-19 Governance: Legacies of Fukushima and Towards New Visions of Expertise,” 4S annual meeting 2022, Cholula, Mexico 2022 年 12 月 7 日
17. 佐藤恭子，田中幹人，寿楽浩太「COVID-19 パンデミックにおける各国社会の対応の比較分析（2）2022 年前半までの分析結果と日本の状況への示唆」2022 年度 STS 学会，2022 年 11 月 26 日
18. 田中幹人「ソーシャルメディアにおける対話の可能性～警戒主義を超えて」日経・FT 感染症会議 2024 年 10 月 22 日
19. 田中幹人「市民の理解・共感を得るために～リスクコミュニケーションの視点から」結核とパンデミック～これまでとこれから by 結核予防会　2024 年 9 月 30 日　招待有り
20. 田中幹人，端希子，于海春，吉田光男（2024）「COVID-19 渦中でメディア発信した専門家への攻撃」人工知能　39(3)365-373.
21. 田中幹人，奈良由美子，武藤香織，小坂健（2024）「専門家」としてのリスクコミュニケーション実践，人工知能　39(3)355-364.
22. 田中幹人，「新型コロナウイルス禍の新聞報道をめぐるリスク・コミュニケーション［コメンタリー］」2023 年社会情報学会　2023 年 9 月 17 日
23. 田中幹人，「COVID-19 の事例から振り返る SNS コミュニケーションの課題」第 97 回日本感染症学会総会・学術講演会 第 71 回日本化学療法学会学術集会 合同学会　2023 年 4 月 29 日　招待有り
24. 田中幹人「リスクコミュニケーションにおけるメディアとサイエンス」ILSI Japan セミナー　2023 年 2 月 8 日
25. 田中幹人「リスク「コミュニケーション」への遠い道：コロナ禍中の実践から」公衆衛生シンポジウム 2022 年 10 月 9 日
26. 田中幹人，石橋真帆，于海春，林東佑，楊鯤昊，関谷直也，鳥海不二夫，吉田光男（2022）「COVID-19 をめぐるメディア・コミュニケーションとその課題」医療と社会，32(1)11-22.
27. Tanaka, M., “Responsible communication of science to the public,” OECD Global Science Forum　2023 年 4 月 21 日　招待有
28. Tanaka, M. “The Fundamentals of Risk Communication: A Message Centered Approach,” Strengthening the Philippine Health Laboratory Network: Learn from Japan and the Philippines　2024 年 9 月 6 日　招待有
29. Tanaka, M., “The gap between theory and Practice: Insights from Japan’s science communication struggle during Covid-19,” “Communicating science effectively? New insights from science communication and science journalism research for researchers’ changing roles towards society,” University of Twente, The Netherlands 2024 年 7 月 12 日　招待有
30. Tanaka, M., Yuriko Chikusa, Lim Dongwoo, Seita Emori, Digging from the tip of the iceberg: Japanese hidden partisanship lies among climate change, Covid-19 and other science topics, CLOUD-C Berlin Meeting, @The Wizenbaum Institute　2024 年 4 月 18 日
31. Tanaka, M., “Session 5. Scientific advice at different scales: coordination and contextualization: Insights from Japan,” OECD Global Science Forum: Scientific advice in crises: lessons learned from COVID-19,”　2022 年 3 月 4 日　招待有り
32. Tanaka, M., “Science Communication in Japan: History, characteristics, and tendencies,” LSC Science Communication Colloquium 2022 年 3 月 2 日
33. 楊鯤昊，田中幹人，（2024）「Wikipedia の COVID-19 関連記事の編集過程から見る科学知の共創過程」人工知能　39(3)394-399.
34. Yang, K., Mikihito Tanaka, “Crowdsourcing Knowledge Production of COVID-19 Information on Japanese Wikipedia in the Face of Uncertainty: Empirical Analysis,” Journal of Medical Internet Research 25(e45024)2023 年
35. 姚遠，吉田光男，田中幹人「Twitter（X）における専門家による COVID-19 リスクコミュニケーションとその受容」社会情報学会 2024 年会 @ 香川短期大学　2024 年 9 月 15 日

36. 于海春・田中幹人（2024）「『英雄』をもって乱を制す―武漢ロックダウン後の Weibo 議論から―」『人工知能』 39(3), 387-393.
37. 于海春・田中幹人（2024 年 12 月 6 日）「専門家によるソーシャルメディアを通じた COVID-19 情報の伝達―日本と中国の比較―」科学技術社会論学会年次大会 2024〔東京大学本郷キャンパス〕
38. 于海春・田中幹人（2023 年 2 月 21 日）「専門家への言及はいかに中国 SNS 上におけるコロナ関連のセンチメントに影響したのか―武漢ロックダウンの事例から―」第 2 回計算社会科学会大会
39. Yu, H., & Tanaka, M.（2022, July 8）. Agenda shifting and sentiment changing in the Japanese newspaper during the COVID-19 pandemic. Paper presented at the IAMCR 2022 Pre-conference “Big Data in Communication Research: A Contextual Turn?”, Online.
40. 于海春・田中幹人（2022 年 2 月 28 日）「新聞における新型コロナ感染症に関する情報伝達と感情変化の実証分析」第 1 回計算社会科学会大会（CSSJ2022）

3. Future Challenges, Prospects, and Recommendations

This research yielded many academic achievements and provided valuable insights into risk communication practices. These findings are expected to offer important implications for experts and specialized organizations when disseminating information through social media during future pandemics.

However, deepening and passing on this practical knowledge on risk communication remains a major challenge. Although numerous academic and practical lessons were learned during the H1N1 pandemic and the Great East Japan Earthquake, this knowledge has dispersed throughout the society and is often referenced in a piecemeal and untimely manner during crises.

To avoid repeating these mistakes, this research will continue to be developed and disseminated not only in academic journals, but also in books for the general public. Simultaneously, efforts to implement knowledge in society will continue.

Finally, this research was made possible by the tangible and intangible support provided by the Hitachi Infectious Disease Research Fund. We would like to express our gratitude and request your continued support in this field. A civil society that can effectively respond to risks such as pandemics can only be achieved through constant efforts, similar to that of democracy.

References

1. Abe, Y.（2017）. Why Manga Matters after Fukushima. *Media-N*, 13（1）. doi:10.21900/j.median.v13i1.4
2. Berndt, J.（2017）. Manga meets Science: Going beyond the Education-Entertainment Divide. In R. Leinfelder, A. Hamann, J. Kirstein, & M. Schleunitz（Eds.）, *Science meets Comics: Proceedings of the Symposium on Communicating and Designing the Future of Food in the Anthropocene*（pp. 41-59）. Berlin: Ch. A. Bachmann Verlag.
3. ぼうごなつこ（2021）.『100 日で収束しない日本のコロナ禍』扶桑社.
4. 石橋真帆，田中幹人，関谷直也（2021）.「新型コロナウイルスに関する情報行動の国際比較」『日本リスク学会第 34 回年次大会講演論文集』Vol. 34, Nov. 20-21
5. Jarreau, P. B., Su, L. Y. F., Chiang, E. C. L., Bennett, S. M., Zhang, J. S., Ferguson, M., & Algarra, D.（2021）. “COVID ISSUE: Visual Narratives About COVID-19 Improve Message Accessibility, Self-Efficacy, and Health Precautions,” *Frontiers in Communication*, 6. doi:10.3389/fcomm.2021.712658
6. Jasanoff, S., & Kim, S. H.（2015）. *Dreamscapes of Modernity*, University of Chicago Press.
7. 小林よしのり（2021）.『ゴーマニズム宣言スペシャルコロナ論 3』扶桑社.
8. 菅原慎悦（2022）.「リスク・ガバナンスと「安全」の「科学化」」関西大学社会安全学部編『検証 COVID-19 災害』ミネルヴァ書房，43-59.
9. Wynne, B.（1998）. May the Sheep Safely Graze? A Reflexive View of the Expert-Lay Knowledge Divide. In S. Lash, B. Szerszynski, & B. Wynne（Eds.）, *Risk, Environment and Modernity: Towards a New Ecology*. London: SAGE Publications.
10. 尾内隆之，調麻佐志（2020）.「新型コロナウイルス感染症対策における科学と政治」,『科学』，90(6): 489-507.
11. 定松淳（2021）.「2020 年コロナ禍・最初の緊急事態宣言までの科学と政治」,『生物学史研究』，101: 25-32.
12. 寿楽浩太（2023）.「第 13 章 各国のパンデミック対応に関する比較分析が与える示唆―科学技術社会論の見地から―」，国立国会図書館立法調査局（編）「科学技術のリスクコミュニケーション―新たな課題と展開―科学技術に関する調査プロジェクト報告書」.
13. 菅原慎悦（2022）.「リスク・ガバナンスと『安全』の『科学化』」，関西大学社会安全学部編『検証 COVID-19 災害』ミネルヴァ書房，43-59.
14. 廣野喜幸（2022）.「危機下の科学的助言―新型コロナウィルス感染症対策専門家会議の「前のめり」をどう評価するか―」,『哲学・科学史論叢第二十四号』，67-107.
15. 本堂毅（2020）.「感染症専門家会議の『助言』は科学的・公平であったか：科学者・医学者の行動規範から検証する」,『世界』，2020 年 8 月号，75-83.

16. 本堂毅（2022）.「空気感染／エアロゾル感染をめぐる国立感染症研究所の考え方と応答」,『科学』, 92（4）: 295-296.
17. 米村滋人（2020）.「感染症対策の法的ガバナンスと専門家の役割」,『法律時報』, 1512:1-3.
18. Jasanoff, S., HIlgartner, S., Hurlbut, J. B., Özgöde, O. and Rayzberg, M.（2021）. “Comparative Covid Response: Crisis, Knowledge, Politics: Interim Report”, https://compcore.cornell.edu/wp-content/uploads/2021/03/Comparative-Covid-Response_Crisis-Knowledge-Politics_Interim-Report.pdf
19. Juraku K, Sugawara S.（2021）. Structural Ignorance of Expertise in Nuclear Safety Controversies: Case Analysis of Post-Fukushima Japan, Nuclear Technology 207（9）: 1423-1441.
20. Sugawara S, Juraku K.（2018）. Post-Fukushima Controversy on SPEEDI System: Contested Imaginary of Real-time Simulation Technology for Emergency Radiation Protection, S. Amir（ed.）, The Sociotechnical Constitution of Resilience: A New Perspective on Governing Risk and Disaster, Palgrave Macmillan, Chapter 9.
21. 松本三和夫（2002＝2012）.『知の失敗と社会――科学技術はなぜ社会にとって問題か』, 岩波書店.
22. 松本三和夫（2009）.『テクノサイエンス・リスクと社会学――科学社会学の新たな展開』, 東京大学出版会.
23. 松本三和夫（2012）.『構造災――科学技術社会に潜む危機』, 岩波新書.

Exploration of Practical Wisdom and Resilience Overcoming Downside Risk — Collecting Grassroots Voices in Africa under COVID-19

Grant Period: from December 1, 2021 through November 30, 2024
Grant Amount: 30 million yen
Principal Researcher: Kazuyo Hanai
Project Assistant Professor, Institute for Future Initiatives, The University of Tokyo

This research project aimed to classify and assess the real and perceived risks associated with both COVID-19 and government responses to the pandemic in sub-Saharan Africa. It also elucidated the people's resilience in overcoming these risks by using their practical wisdom. Research countries included the Democratic Republic of Congo, Ethiopia, Kenya, South Africa, Tanzania, Uganda, and Zimbabwe. We collected "grassroots voices" during the COVID-19 pandemic through field research in collaboration with local research institutions and online communication tools, and dynamically clarified how people overcame risks over time. In particular, this research makes an important contribution by showing that governments' potential politicization of COVID-19 prevention measures and people's distrust of the government could decrease the effectiveness of their policies.

1. Research Objectives: Listen to grassroots voices and draw lessons

This research project collected grassroots voices in sub-Saharan Africa and explores how local people perceived and coped with the impact of the COVID-19 pandemic and government prevention policies on their daily lives. The study draws lessons from the COVID-19 experience not only from policymakers' perspectives but also from those of ordinary people and thereby contributes to discussions in the international community as it prepares for the next pandemic.

In particular, this research makes a significant contribution by revealing that governments' potential politicization of COVID-19 prevention measures and people's distrust of the government could hinder the effectiveness of their policies. Several countries faced criticism that politicians used government prevention measures to garner votes and favor the governing party in elections. Such biased policies decrease people's trust in government and can harm preventive measures and vaccine dissemination. While rapid implementation of these measures is vital in preventing pandemics, policymakers should carefully consider them from the perspective of protecting vulnerable populations and guaranteeing human rights. On the other hand, our survey revealed that people's perceptions of the government and its policies are complex and multifaceted, often depending on the passage of time and the outcome of the policy. Moreover, ordinary people, in pursuit of survival, improvised creative activities to maintain their livelihoods while maneuvering the containment measures. It is also essential to understand the sources of people's resilience in times of hardship and to empower them with public assistance during regular times.

2. Background: COVID-19 in Sub-Saharan Africa

Approximately 12.2 million COVID-19 cases and over 256,000 deaths were reported in Africa as of 2

January 2023 (Africa CDC 2023)[1]. The highest number of infections was about 4 million in South Africa, and about 1.2 million in Morocco and Tunisia (JHU 2023). These figures are not substantial compared to the 100 million people infected in the United States, and the 30 million in France and Germany. However, this became clear only later. When COVID-19, then an unknown virus, appeared in China in December 2019 and began spreading worldwide in early 2020, African governments, international organizations, and experts were concerned that the virus could cause severe damage if it landed on the African continent. This concern existed because sub-Saharan African countries lacked the necessary systems, including PCR testing, isolation, and contact tracing infrastructure, to handle such a health shock (WHO 2020). Furthermore, Africa was expected to struggle to produce the vaccine or acquire it from the supply chains of developed countries.

For this reason, governments implemented strict measures at a very early stage. In East Africa, the first confirmed cases were reported in Kenya on March 13, 2020, followed by Rwanda on March 14, and Tanzania on March 16. These cases prompted governments to implement containment policies because of concerns about the spread of infection. By May 2020, 26 sub-Saharan African countries had issued a State of Emergency, 34 countries had implemented lockdowns, and 46 countries had closed their borders (UN 2020). Rather than reacting to the spread of infection as an aftereffect governments adopted strict preventive measures in advance.

It is difficult to determine whether the low number of cases in Africa compared to other regions results from the success of containment policies, the high proportion of young people in Africa, or the unknown actual number of cases because of limited testing. In

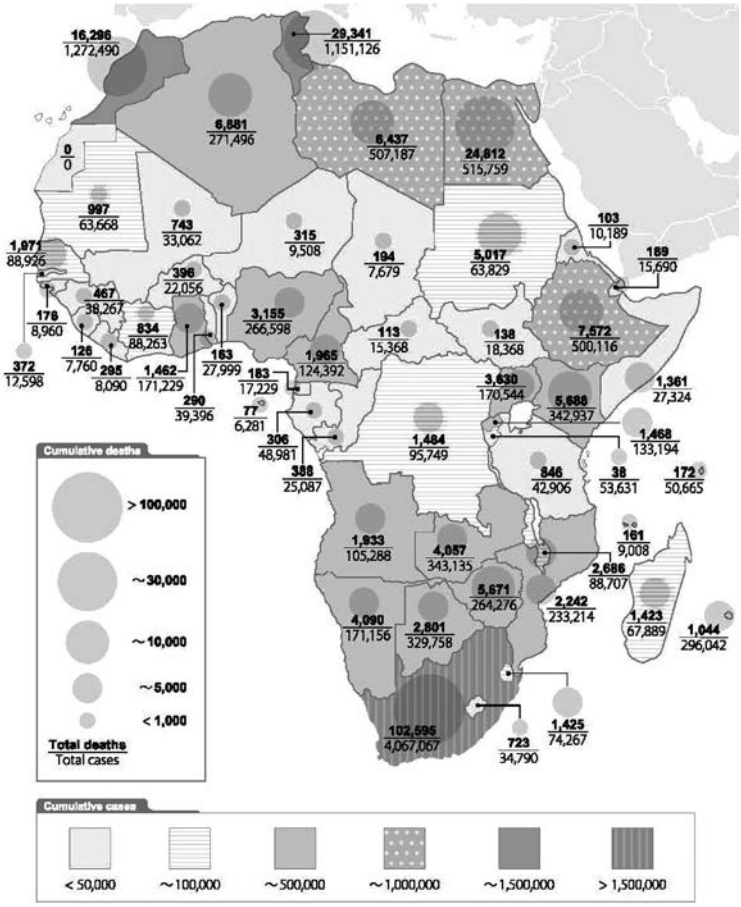

Fig. 1 Cumulative confirmed COVID-19 cases and deaths in Africa, as of March 2023
Source: Made by authors based on data from JHU [2023]

1) Medical authorities and research institutions stopped collecting data in 2023.

particular, it is difficult to conclude that strict containment policies have successfully controlled the pandemic in Africa and saved lives. This is not only because of the serious direct effect of the pandemic but also its indirect effect on daily life through containment measures. Restrictions on economic activities decrease economic benefits and remove livelihoods, especially for people living on the margins of society. These restrictions often drive people further into poverty, hardship, and even death.

We observe that risk tradeoffs occurred not only during the COVID-19 pandemic, but also in the effects of countermeasures on people's livelihoods, which exposed them to hunger and increased other infectious diseases. In this research, risk refers to the likelihood that something negative will occur and harm a valuable aspect of human life. When well-intentioned efforts to mitigate and target risk are found to increase other risks, this situation is called a risk tradeoff. According to Graham and Winner (1997), leading researchers in this field, the types of risk tradeoffs depend on the type of risk being targeted, countervailing risks, and the population affected:

(1) *Risk offset* occurs when the target and countervailing risks are of the same type and affect the same population. For example, a COVID-19 containment policy, including vaccination, may increase the risk of other diseases in the same population.
(2) *Risk substitution* occurs when the target risk affects different types of risks within the same population. For example, a COVID-19 containment policy may increase the risk of poverty for the same population.
(3) *Risk transfer* occurs when the target risk affects the same type of risk in different populations. For example, the risk of infection in Region B may increase because vaccine distribution is prioritized in Region A.
(4) *Risk transformation* occurs when target risks affect different types of risks for different populations. For example, enhanced COVID-19 control in urban areas may lead to a deterioration of livelihoods in rural areas.

In analyzing these risk tradeoffs, it is necessary to understand the risks to which people in the research site are exposed, beyond COVID-19. In our seven-country questionnaire survey, described in detail in the next section, we listed 15 risks to assess people's risk perceptions. As a result, people in the target area do not perceive COVID-19 as a high risk. Instead, economic deprivation and other problems are more severe for people.

This research advances the discussion by proposing the concept of viewing COVID-19 as a "downside risk." Downside risk is originally an economic term that refers to the possibility that money or the value of something might be lost below target or expected returns. However, Amartya Sen's report on human security uses the term more broadly to describe the danger of "sudden deprivation," which exposes vulnerable populations to multiple hardships (Sen 2003). The COVID-19 pandemic and government policies affect not only the risk of COVID-19 infection but also the risk of other diseases worsening, the risk of poverty and hunger because of deteriorating livelihoods, the risk of losing access to education because of the closure of educational institutions, and the risk of domestic violence and crackdowns. Therefore, COVID-19 can be considered a downside risk that may induce diverse risks affecting people and cause multiple types of risk tradeoffs. Because of this perspective, this research examines risk from the perspective of those exposed to risk, not only in relation to COVID-19, but also with respect to other risks.

In addition, we observed that people overcame the harsh environment despite lacking public services and support. Therefore, we have endeavored to capture the coping strategies people use to overcome risk by drawing on the wisdom of life around them. People demonstrate resilience through various coping strategies adopted to recover deteriorating livelihoods and regain lost educational opportunities. Resilience is a psychological term that refers to the ability to overcome difficulties flexibly. It describes a state in which a person recovers from reduced functionality due to stress and returns to, or even exceeds, their original functionality. In the case of the COVID-19 pandemic, until 2022, when COVID-19 was mainly considered under control in Africa, the pandemic affected people repeatedly, and measures were implemented multiple times. Nevertheless, the strategies used to restore people's ability to function should also be considered an essential lesson from the COVID-19 pandemic.

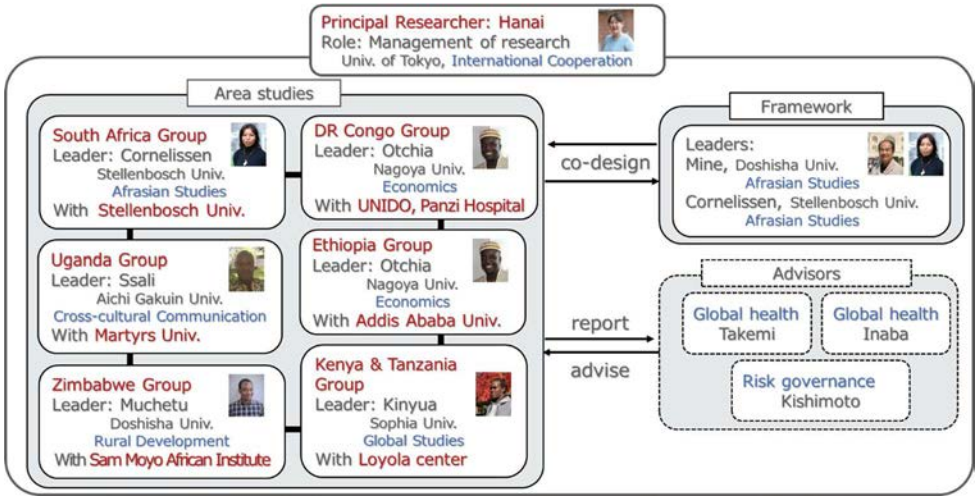

Fig. 2 Implementation structure

3. Research Methods

This research adopted interdisciplinary research methods in the social sciences, using the following six phases.

3.1 Organizing research teams

We collaborated with local research institutions in seven target countries (Democratic Republic of Congo, Ethiopia, Kenya, South Africa, Tanzania, Uganda, and Zimbabwe), and formed six research teams led by African researchers based in Japan. Kenya and Tanzania formed a joint team.

3.2 Literature survey

By collecting and analyzing research papers and reports from international organizations on the COVID-19 pandemic in Africa, and by carefully reviewing previous research on risk perception, we formulated three hypotheses from the perspective of risk perception and risk trade-offs.

- Hypothesis 1: People perceive other risks as more likely or serious than COVID-19, even during the pandemic.
- Hypothesis 2: People are more at risk for the impact of containment measures on their lives than for the pandemic itself.
- Hypothesis 3: Perception of COVID-19 as a risk depends on trust in government policies.

3.3 Questionnaire survey: online survey common to seven countries

Based on the above hypotheses, we created a questionnaire that forms the core of this research. We obtained a total of 840 responses through an online questionnaire survey using a data platform.

3.4 Field survey: interviews and focus group discussions

Based on the results of the questionnaire survey, we formulated research plans and conducted field surveys in collaboration with local research institutions. The specific research topics and methods varied by country because the social impact of COVID-19 differed in each target country, and the subjects to be investigated in detail also differed. We collected approximately 1,760 responses from seven countries through face-to-face or online interviews and focus group discussions.

3.5 Discussions among collaborative researchers

Team research meetings occurred as needed. Over the three years, the team held nine general research meetings to share research information and report progress.

- FY2021–22: 7 December 2021, 15 February and 3 June 2022, and 25 January 2023
- FY2023: 15 April 2023, and 20 January 2024
- FY2024: 2 September, 6 September and 18 October 2024

Photo 1 Presentation at JSAS conference

Photo 2 Online symposium

3.6 Information disclosure and discussion in the research community

We held an online symposium once a year, for a total of three times. Additionally, we held four forums at the Japan Society for Afrasia Studies (JSAS) and the Japan Association for African Studies (JAAS) to share our research ideas and progress.

- FY2022: 9 July 2022 JSAS, and 21 February 2023 Online symposium
- FY2023: 13 May 2023 JAAS, 7 October 2023 JSAS, and 9 February 2024 Online symposium
- FY2024: 29 September 2024 JSAS

4. Survey Results

In this section, we describe the results of the common questionnaire survey and the surveys conducted by each country team. In the next section, we present the research results obtained from the entire study. For detailed survey results, please refer to the book *Practical Wisdom and Resilience Overcoming Downside Risk: Grassroots Voices in Africa under COVID-19* (Springer, 2025), published in May 2025.

4.1 Risk perception observed in a questionnaire survey common to seven countries

Based on the hypotheses, we created a questionnaire that formed the core of this research and conducted an online questionnaire survey using a data platform in March 2023. We collected 840 responses: 132 from Congo, 128 from Ethiopia, 117 from Kenya, 150 from South Africa, 99 from Tanzania, 115 from Uganda, and 99 from Zimbabwe.

In the survey, we identified fifteen risks: malaria infection, HIV/AIDS infection, Ebola virus infection, injuries in an accident, domestic violence, street violence, involvement in armed conflict, job loss, economic distress or financial problems, food shortage, natural disaster, political repression, catching the coronavirus or COVID-19, injustice, and corruption or fraud. Here, we highlight three notable findings from the survey results. First, people in the target area do not perceive COVID-19 as a high risk (Fig. 3). The overall average risk perception of COVID-19 was low, at 3.2 on a scale of 7. When compared with the other fourteen types of risk, COVID-19 ranked between seventh and eleventh in all countries. In six of the seven countries, economic distress was the number one risk, while only Ethiopia cited corruption and fraud. Second, in addition to direct and indirect experiences with COVID-19 infection, trust in the government, science, and medical experts significantly affects risk perception. In all seven countries, trust in the government was low, with an average rating of two or less on a five-point scale. Trust in science and medical experts was relatively high, with an average rating of three to four. A trend was observed: higher levels of trust in science and medical experts corresponded to higher perceptions of COVID-19 risk. Third, the depth of religious belief appears to influence the decision to receive a vaccine. However, because the results varied by country, further details were left to individual field surveys.

4.2 South Africa: Middle-class experience during the pandemic

A South African team, in collaboration with Stellenbosch University, surveyed the experiences and roles of middle-class citizens. Previous studies have examined the impact of COVID-19 in South Africa,

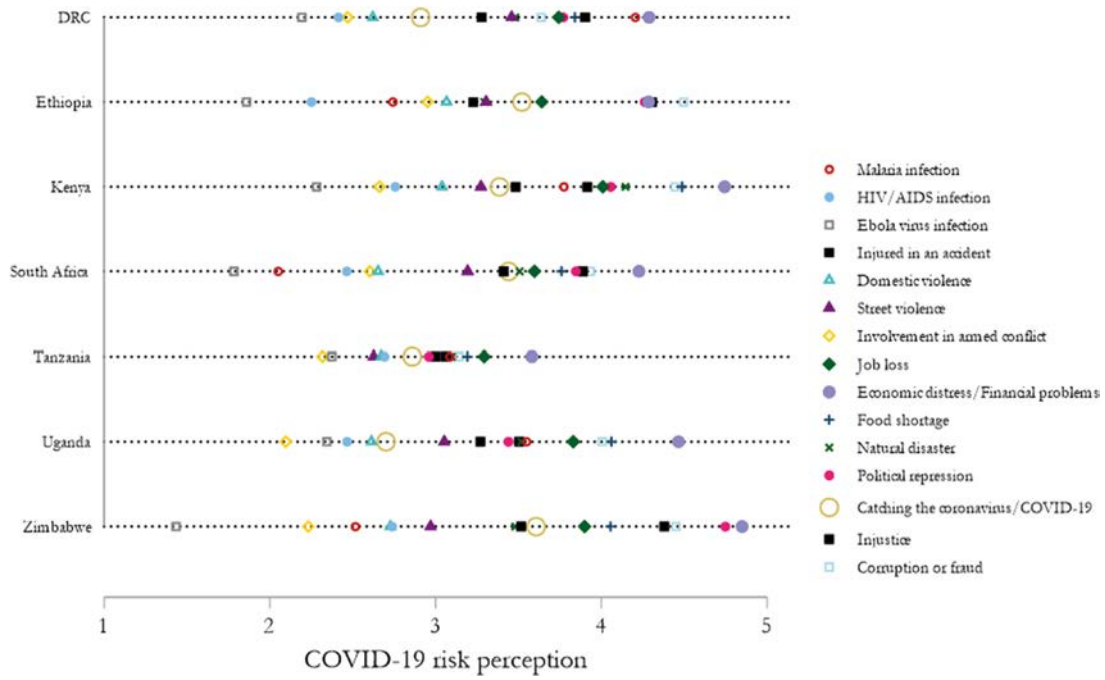

Fig. 3 The multitude of risks during the COVID-19 pandemic
Source: Made by Christian Otchia based on questionnaire survey

the country most severely affected on the African continent. However, most of these studies have focused on poor and vulnerable populations and the experiences of middle-class citizens have not been analyzed. The South African team conducted a large-scale online survey of 520 people and semi-structured online interviews with 20 middle-class citizens. The results show that even in South Africa, where the number of infections was high, COVID-19 was no longer perceived as a serious risk. Economic shock and service delivery failure were perceived as greater risks.

Another interesting finding was that although people did not trust the government, they evaluated its policy interventions during the COVID-19 pandemic as appropriate. They also accepted that it was inevitable for the government to focus on supporting the poor. Middle-class citizens overcame difficulties through their connections with their families and civil society. Middle-class citizens also contributed to the resilience of society as a whole by paying tax and providing assistance to family and relatives. While the term "Black tax," which refers to the burden borne by emerging black middle class, is often used in a negative context, some respondents equated it with the spirit of Ubuntu, which emphasizes mutual support among people.

4.3 Zimbabwe: Life changes in rural and urban areas

The Zimbabwe team, in collaboration with the Sam Moyo African Institute of Agrarian Studies (SMAIAS), conducted face-to-face interviews with 175 people, mainly rural residents, and online focus group discussions with 69 participants, given the high concentration of rural populations in Africa. In addition, by comparing the experiences of urban areas, the research comprehensively analyzed how risk perception, government containment measures, resilience mechanisms, and autonomy differed across environments. The results showed that although the infection and death of a prominent figure in the early stages of the pandemic shocked people in Zimbabwe and contributed to increased risk awareness, risk perception of COVID-19 was not high compared to other risks. Nevertheless, the data showed that a typical risk tradeoff occurred, in which the focus on infectious diseases diverted attention from agricultural risks, leading to increased economic shocks. Furthermore, the findings showed that while people harshly criticized corruption—such as individuals who should have been restricted from traveling being able to do so through bribery, thereby becoming sources of infection, or being required to pay bribes for certificates necessary to access markets—

they nonetheless supported the policies. In Zimbabwe, the team found that the root of people's resilience lies in community connections and informal support networks.

4.4 Uganda: Politicization of COVID-19

The Uganda team, in collaboration with Uganda Martyrs University, conducted face-to-face interviews with 172 respondents. The team found that citizens recognize the government intervention policy as a more serious risk than the pandemic itself. Many people think the strict lockdown by the government is a more serious risk than the pandemic itself. Additionally, because the general elections were held in 2021 during the pandemic, there were many complaints that President Yoweri Museveni and his ruling party, the National Resistance Movement (NRM), used COVID-19 intervention measures to gain an advantage in the election campaign. When ruling party candidates held gatherings, it appeared that there was no pandemic, but when opposition candidates tried to hold gatherings, authorities shut them down because of infection control measures. Despite this, after the second pandemic wave in 2021, people praised the central government's strict policies for preventing the pandemic, while expressing disappointment that local governments had not taken effective measures. This was a surprising change even for the researchers who conducted the survey. After analyzing the factors, the team concluded that the pandemic had exposed the decline in the response capabilities of local governments because of the long-standing centralization policies of the Museveni administration, which is considered semi-authoritarian.

4.5 Kenya & Tanzania: Hustling as students' resilience

A joint team from Kenya and Tanzania, in collaboration with the Loyola Centre for Media and Communications, examined students' coping strategies because young people's actions have a significant political and social effect in both countries. The team conducted an online questionnaire survey with 100 respondents, face-to-face interviews with 171 people, and focus group discussions with 20 participants. In both countries, the transition to online learning began early in the pandemic. This change placed various burdens on students, for example, the need to prepare digital equipment. Additionally, the economic shock caused a decrease in the income of parents who provide tuition fees. Therefore, students began starting businesses to earn alternative income. Initially, this included sales of small items such as food and masks. With the transition to online learning, students shifted to creating content using digital platforms. This youth entrepreneurship, called "Hustling," spread and was also used by politicians to support young people for vote-collecting before the 2022 elections. Overall, in Kenya and Tanzania, hustling, which uses informal networks rooted in local communities, has become a coping strategy.

4.6 Ethiopia: Impact of misinformation on vaccination

The Ethiopia team, in collaboration with Addis Ababa University and the Ethiopian Investment Commission, analyzed the effect of the global spread of misinformation through social media and other channels on vaccination behavior. In Africa, people tend to trust information shared through social media and networks of family and friends more than official government information. This tendency increases the spread of misinformation. In this survey, the team examined the effect of general misinformation, such as the belief that garlic and ginger have preventive effects, and deliberate misinformation based on conspiracy theories, such as the belief that vaccination causes infertility, on vaccination behavior. The team used an online questionnaire survey of 380 people and focus group discussions with 21 participants. The results showed that general misinformation has the greatest influence. Belief in misinformation is affected by trust in religious and scientific authorities, and medical professionals. Additionally, trust in these experts is affected by religious beliefs. Therefore, the study concluded that any public health communication strategy must consider the religious context of the target population. A targeted communication strategy is necessary to address and correct misinformation by collaborating with key persons, such as trusted traditional leaders, based on an understanding of local history and culture.

Photo 3 Field research in Zimbabwe

Photo 4 Research conference in Zimbabwe

4.7 DR Congo: Impact on self-esteem among vulnerable women

The DRC team recognized that the COVID-19 pandemic coincided with a severe deterioration in the conflict situation. The team collaborated with the United Nations Industrial Development Organization (UNIDO) and Panzi Hospital to conduct interviews with 330 women, including internally displaced persons (IDPs) affected by the conflict, victims of sexual violence, and women in communities hosting IDPs. The aim was to analyze the impact of COVID-19 on self-esteem, which is considered to have a significant influence on women's resilience. The results showed that the loss of livelihoods and income, food insecurity, and limited healthcare access had a significant impact on women's resilience. Furthermore, the reduction in participation in community activities led to a decrease in the social capital necessary for women's resilience. This survey showed that IDPs and victims of sexual violence are already in a vulnerable position. It also showed that participation in livelihood recovery activities conducted by international aid agencies, local medical institutions, and civil society organizations is vital for resilience. However, restrictions imposed because of infectious disease prevention measures left women with no remaining capacity to absorb shocks. Based on these findings, the team called for support for the livelihoods of vulnerable women, which are the foundation of their resilience.

5. Research Results and Policy Recommendations

Based on the survey results from the seven countries, we identified four overall findings. First, risk perception of COVID-19 was low. The impact of economic shocks caused by government policies was perceived as more serious. Therefore, a risk trade-off occurred. Second, politicization of containment policies was observed, and the limited spread of the pandemic in Africa, compared to initial fears, affected people's perception of the "success" of the policies and led to a high evaluation of the government. Third, the effect of misinformation on vaccination behavior was revealed. Fourth, the reality of coping strategies to overcome difficulties was portrayed. Thereby, the importance of informal networks in African countries as a root of resilience was depicted.

Based on the results of the survey, we propose four recommendations to the international community to prepare for future outbreaks of infectious diseases.

First, it is necessary to address the risk trade-offs posed by infectious disease countermeasures. To avoid a trade-off between prioritizing infectious disease countermeasures and maintaining economic activity, the survey suggests the need to achieve an appropriate balance between these priorities, or to implement infectious disease countermeasures and more rapid, effective economic countermeasures simultaneously.

Second, we note that the politicization of pandemics or the high evaluation of government resulting from severe infectious disease control can lead to a crisis of democracy. Experts warn that people's acceptance of strong government power during a pandemic can cause a crisis of democracy. In our research, we found significant politicization of anti-pandemic policies in Uganda and Kenya, where elections occurred during the pandemic. People reported short-term problems and corruption related to strict lockdowns. However, over time, people became more willing to accept severe policies and allowed the government to have more power. Awareness of the future risks associated with this trend is necessary.

Third, because all countries show that the roots of resilience lie in informal networks, we advocate for aid that supports these networks from peacetime. Aid from

international organizations tends to focus on formalizing the informal sector in the Global South. However, given that informal networks are key to resilience when the world is in crisis and neither aid nor public assistance can reach affected populations, it is important to support the formation and maintenance of informal networks that promote mutual support among people.

We published our research findings and recommendations in an English book through Springer in May 2025. We presented these findings at international conferences in June and September 2025. We will release them as policy recommendations from the Institute for Future Studies (IFI) of the University of Tokyo in September 2025. These activities contribute to international discussions on pandemic preparedness.

6. Future Prospects

Owing to the strong support from the Hitachi Foundation for collaboration with local research institutions, research institutions in seven African countries played a central role in the survey. This involvement contributed to the improvement of research skills and networks, which was also a major achievement. In Uganda, South Africa, Kenya, Tanzania, and Zimbabwe, research workshops and conferences were organized locally, providing opportunities for discussion with local researchers and practitioners. In Zimbabwe, a book co-authored by local researchers is planned for publication. The research foundation established through this research is expected to continue to develop further in the future through the efforts of local researchers.

Main Publications and Conference Presentations

(1) Journal Article

Hanai, Kazuyo, Christian S. Otchia, Kithinji L. Kinyua, Rangarirai Muchetu (2023) "The 60th JAAS Annual Conference, Forum Report on Exploration of Practical Wisdom and Resilience Overcoming Downside Risk: Collecting Grassroots Voices in Africa under COVID-19," JAAS *African Research,* No.104.

(2) Book Publication

Hanai, Kazuyo, Rangarirai Muchetu, Kithinji L. Kinyua, and Yoichi Mine eds. (2025) *Practical Wisdom and Resilience Overcoming Downside Risk: Grassroots Voices in Africa Under COVID-19*, Springer.

Rangarirai Muchetu ed. (Forthcoming) *Innovative Resilience: Zimbabwean Peasants in the Face of COVID-19*, Routledge.

(3) Research Presentations at International Conference

Ssali, Vick L., "Bridging Continents through Collaborative Research on Covid-19 Resilience in Africa," The Africa-Asia, A New Axis of Knowledge conference (AAC3), at Université Cheikh Anta Diop, Senegal, on 11-14 June 2025.

Kinyua, Kithinji L. "Muting the discordant dirge: politics of death in COVID-19 Kenya and Tanzania," The Sixth South Africa Japan University Forum (SAJU6), at Stellenbosch University, South Africa, on 27 August 2024.

Sato, Chizuko and Tomohiro Hosoi "Risk perceptions, resilience and evaluation of government policies during the COVID-19 Pandemic in South Africa: A Study of the middle class," The Sixth South Africa Japan University Forum (SAJU6), at Stellenbosch University, South Africa, on 27 August 2024.

(4) Forum and Sumposium at Academic Conferences

Hanai, Kazuyo, Christian S. Otchia, Kithinji L. Kinyua, Rangarirai Muchetu, Tomohiro Hosoi, and Wakiko Ohira "Exploration of Practical Wisdom and Resilience Overcoming Downside Risk: Collecting Grassroots Voices in Africa under COVID-19," The Fourth JSAS Annual Conference, at Kyoto, on 28 September 2024.

Hanai, Kazuyo, Vick L. Ssali, Tomohiro Hosoi "Roundtable on Exploration of Practical Wisdom and Resilience Overcoming Downside Risk: Collecting Grassroots Voices in Africa under COVID-19," The 3rd JSAS Annual Conference, at Nagoya, on 7 October 2023.

Hanai, Kazuyo, Christian S. Otchia, Kithinji L. Kinyua, Rangarirai Muchetu "Forum on Exploration of Practical Wisdom and Resilience Overcoming Downside Risk: Collecting Grassroots Voices in Africa under COVID-19," The 60th JAAS Annual Conference, at Makuhari, on 13 May 2023.

Christian S. Otchia "Exploration of Practical Wisdom and Resilience Overcoming Downside Risk: Collecting Grassroots Voices in Africa under COVID-19," The Second JSAS Annual Conference, at Tokyo University of Foreign Studies, on 9 July 2022.

References

Africa CDC. (2023). *Coronavirus disease 2019: Latest updates on the COVID-19 crisis from Africa CDC.* https://africacdc.org/covid-19/

Graham, J. D., & Wiener, J. B. (1997). *Risk vs risk: Tradeoffs in protecting health and the environment.* Harvard University Press.

Johns Hopkins University and Medicine (JHU) Coronavirus Resource Center. (2023). *COVID-19 dashboard.* https://coronavirus.jhu.edu/map.html

Sen, A. (2003). *Development, rights, human security. Human security now: Commission on human security*, Boxes1.3, 8–9. Commission on Human Security.

United Nations (UN). (2020). *Policy brief: Impact of COVID-19 in Africa*.

World Health Organization (WHO). (2020). *Strategic response to COVID-19 in the WHO African region: February to December 2020*. https://www.afro.who.int/publications/strategic-response-covid-19-who-african-region-february-december-2020

【Note】This research project was conducted in collaboration with the following members.

- Joint researchers *Titles as of September 2025
  Scarlett Cornelissen (Professor, Stellenbosch University), Tomohiro Hosoi (Lecturer, Gunma University), Laban Kithinji Kinyua (Visiting Researcher, Tokyo University of Foreign Studies), Jean-Claude Maswana (Professor, Ritsumeikan University), Yoichi Mine, (Visiting Professor, Ritsumeikan University, and Executive Director, Japan International Cooperation Agency Ogata Sadako Research Institute for Peace and Development), Rangarirai Gavin Muchetu (Lecturer, Rikkyo University), Wakiko Ohira (Assistant Professor, Sophia University), Christian Samen Otchia (Associate Professor, Nagoya University), Chizuko Sato (Professor, Tokyo University of Foreign Studies), Vick Lukwago Ssali (Lecturer, Aichi Gakuin University)
- Research Collaborators
  Deresse Fekadu Nigussie, Ethiopian Investment Commission (Ethiopia), Elias Mokua, Loyola Centre for Media and Communications (Kenya & Tanzania), Maureen Obare, The Proposed Hekima University (Kenya & Tanzania), Odomaro Mubangizi, The Proposed Hekima University (Kenya & Tanzania), Denis Musinguzi, Uganda Martyrs University Nkozi (Uganda), Nakabuye Juliet Musoke, Uganda Martyrs University Nkozi (Uganda), Walter Chambati, University of South Africa (Zimbabwe), Steve Mberi, Sam Moyo Africa Institute for Agrarian Studies (SMAIAS) (Zimbabwe)
- Research Collaborate Institutions
  Adis Ababa University (Ethiopia), Uganda Martyrs University Nkozi (Uganda), Ethiopian Investment Commission (Ethiopia), United Nations Industrial Development Organization (UNIDO), Sam Moyo, African Institute of Agrarian Studies (Zimbabwe), Stellenbosch University (South Africa), Panzi Hospital (DRC), Loyola Centre for Media and Communications (Kenya)
- External Advisors
  Atsuo Kishimoto (Professor, Osaka University), Masaki Inaba (Co-Chairs, Director of Global Health Program, Africa Japan Forum), Ayako Takemi (Associate Professor, The University of Tokyo)

Implementing Wastewater-Based Epidemiology in Asian Communities to Strengthen Resilience against Pandemics

Grant Period: from December 1, 2021 through November 30, 2024
Grant Amount: 29.99 million yen
Principal Researcher: Eiji Haramoto
Professor, Interdisciplinary Center for River Basin Environment, University of Yamanashi

In this project, we worked on developing technologies and frameworks to monitor the spread of various infectious diseases, including coronavirus disease 2019 (COVID-19), using wastewater-based epidemiology (WBE) in six Asian countries: Japan, Indonesia, Nepal, the Philippines, Thailand, and Vietnam. Following the international meeting "COVID-X Bangkok Meeting," which was attended by the whole project teams, we advanced technology transfer and initiated routine sampling in each country. This enabled us to conduct WBE not only for severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) but also for pathogenic viruses such as noroviruses and pathogenic bacteria such as *Salmonella* spp. The network established through this project is expected to continue to be utilized, and it is anticipated that WBE will spread to other Asian countries as well.

1. Research Objectives

This project aimed to develop a system where WBE is applied to monitor SARS-CoV-2, as well as its variants and findings are conveyed to decision makers in Japan, Indonesia, Nepal, the Philippines, Thailand, and Viet Nam. Through building a comprehensive framework including technology and governance, this project aimed to contribute to building resilience in various communities across Asia as well as contribute to the achievement of global goals.

2. Research Methods and Progress

At the beginning of the research, because of the impact of travel restrictions due to the spread of the COVID-19 pandemic, the research was conducted through online meetings. General meetings attended by members from all six countries were held, and individual meetings were held periodically to discuss in detail matters specific to each country's team, such as confirmation of detailed water sampling points and methods, and optimal detection methods according to the conditions of the laboratory equipment in each team. At the general meeting, we instructed the participants on the procedures in the Japanese laboratory online, but it was recognized as an issue that the contents of the instruction might not be sufficiently conveyed online, leading to the holding of the face-to-face international meeting "COVID-X Bangkok Meeting" as described below.

In Thailand, Indonesia, and Nepal, where wastewater sampling was previously done, wastewater sampling could be smoothly initiated. Sampling was subsequently started in Vietnam and the Philippines, and full-scale WBE was initiated in all countries. In each country, the wastewater sampling was conducted, wastewater was processed to the concentration step, and after transporting the concentrated samples, microbes were measured in Japan. In Japan, in addition to SARS-CoV-2, pathogenic viruses such as noroviruses and pathogenic bacteria such as *Salmonella* spp. were also tested.

Figure 1. Photos of the COVID-X Bangkok Meeting

Figure 2. Photos of the site visit

3. Research Achievements

3.1 COVID-X Bangkok Meeting

The international conference "COVID-X Bangkok Meeting" was held at Chulalongkorn University in Bangkok, Thailand, in January 2023. This meeting was organized and managed by the Thailand team and was the first opportunity for key members from all six countries to gather together. As shown in Figure 1, the event consisted of site visit, symposium, workshop, and laboratory tour.

3.1.1 Site visit

We visited a wastewater treatment plant, and after a briefing on the status of wastewater treatment in Bangkok, we toured the actual treatment facilities. We also confirmed the operation of the automatic water sampler used by the Thailand team. In addition, since river and canal water impacted by untreated wastewater can be used as a sampling point in areas with low sewerage coverage, we visited a bridge over a canal and demonstrated how to collect water from a depth of about 30 cm below the water surface using a water sampling device (Figure 2).

3.1.2 Symposium

A symposium entitled "Wastewater-based epidemiology for tracking the COVID-19 pandemics and the SARS-CoV-2 contamination in water: Case studies in Asian communities" was held inviting government officials from Thailand. The symposium was attended by more than 50 participants, and each country team reported on the latest status of the COVID-19 pandemic in their respective countries, the establishment of standards for WBE, and the progress of the project (Figure 3).

3.1.3 Workshop

A two-day workshop was held with the participation of project members only. First, the monitoring results of SARS-CoV-2 and other pathogenic viruses (e.g., noroviruses) in wastewater in various countries measured by the real-time PCR (qPCR) were shared by the Japan group, and the mobile qPCR and high-throughput qPCR were introduced as novel technologies to discuss their potential use in this project. Next, the

Figure 3. Photos of the symposium

Figure 4. Photos of the workshop

participants were divided into groups by country, and the goals to be achieved and necessary processes of the project in each country were organized and shared with the whole group. Then, the participants were randomly divided into three groups to discuss the future direction of the project (Figure 4).

Table 1 shows the achievements and challenges of the project summarized by each country team during this workshop. While each team was able to start full-scale WBE with 50 to 400 wastewater samples collected, some issues were identified, such as the breakdown of laboratory equipment, including centrifuges used in the concentration process of wastewater samples and freezers for storage of samples, and the fact that purchasing consumables is not easy due to budget and distribution constraints. During the discussion, the following points were raised as common requests, and it was decided to incorporate them in future activities.

- Application of WBE to infectious diseases other than COVID-19.
- Technology transfer through visits by the Japan team.
- Development of cheaper, simpler, and more rapid detection methods.
- Development of detection manuals and guidelines.
- Mapping wastewater monitoring data using GIS.
- Holding training workshops.

Table 1. Achievements and challenges summarized by each country team during the workshop

Team	1. What have you achieved so far?	2. What are your challenges?	3. Are there any solutions you can propose to address those challenges?
Nepal	· Over 300 samples collected for a year · Access to PCR obtained	· No consumables (procurement is a challenge) · Equipment difficult to repair · Bureaucratic/administrative challenges	· Collaboration with other institutes within Nepal · Outsourcing
Indonesia	· 144 samples collected · Access to PCR obtained	· Analysis not conducted yet · qPCR machine is different – not known whether it is applicable to current protocol	· Students from Japan to visit Indonesia · Positive control samples/primers/probes/standards to be procured (to discuss bilaterally for further info)
Philippines	· Established 3 sampling sites · 96 samples collected (pellets and supernatant)	· Storage (−20°C) · Labs closed during COVID-19 · Equipment including −80°C freezer out of order	· Equipment needs to be repaired · Need second budget installment · Try to keep samples frozen · Japan team to send reagent asap
Thailand	· Papers · Samples (pellets) sent to Japan · Guideline with Ministry of Public Health	· Implementation/application – difficult to get government interest · Domestic funding · Conventional methods are expensive	· International funding · WBE for other diseases being considered · Cheaper methods to be developed · Consider next steps
Viet Nam	· 400 samples taken: 350 samples sent to Japan · Taking samples once/week · Can collaborate with other institutes for PCR	· Access to wastewater treatment plant · Storage space: −80°C freezer not working. Waiting for new freezer. Currently using −20°C freezer · Consumables · Budget	· Technology transfer · Address other diseases (dengue, hepatitis, etc.) · Journal publications · Recruit PhD student to work on project

- Exchange of researchers and students.
- Continuous acquisition of research funds.
- Writing of papers and conference presentations.

3.1.4 Laboratory tour

Since it is essential to adopt a single detection method throughout the project to enable data comparison among countries, we demonstrated the measurement work in the laboratory and confirmed the work procedures in detail. To confirm the status of laboratory facilities in each country, three of the four graduate students from the Japan group who participated in the meeting visited Indonesia and one visited Nepal for follow-up.

3.2 Major findings from WBE conducted in each country

In Indonesia, WBE was conducted at two WWTPs in Bandung City, one at a centralized WWTP with a treated population of approximately 400,000 and the other at a decentralized WWTP serving approximately 300 people. The detection ratio of SARS-CoV-2 in influent of WWTP was 83%, confirming that the viral concentration in influent increased during periods when the number of infected patients was high. In addition, the results of qPCR targeting the mutation sites of SARS-CoV-2 variants showed that the mutations possessed by the Delta variant were frequently detected in the first wave in 2021, while those possessed by the Omicron variant were detected in the next, larger wave. In other words, different variants were prevalent in each wave (i.e., the Delta variant in the first wave and the Omicron variant in the second wave), indicating that WBE can be used to efficiently determine the prevalence of variants in communities.

In the Philippines, the approach that water from canals with large inflows of untreated sewage was considered as “wastewater” was adopted because of the low coverage of WWTPs in the country. Monitoring of SARS-CoV-2 including the Omicron variant was conducted at two canals and a sewage treatment plant in Manila, and SARS-CoV-2 was successfully detected in response to the number of infected patients.

In Vietnam, monitoring of SARS-CoV-2 including the Omicron variant was conducted in Hanoi at three locations along rivers that received a large amount of sewage. The results confirmed that viral concentrations were 2 to 4 weeks ahead of the number of reported COVID-19 cases, indicating that, as in the Philippines, WBE targeting river water can be effective in developing countries (Figure 5).

In Thailand, WBE was conducted at WWTPs in Bangkok and Phuket, which are frequented by interna-

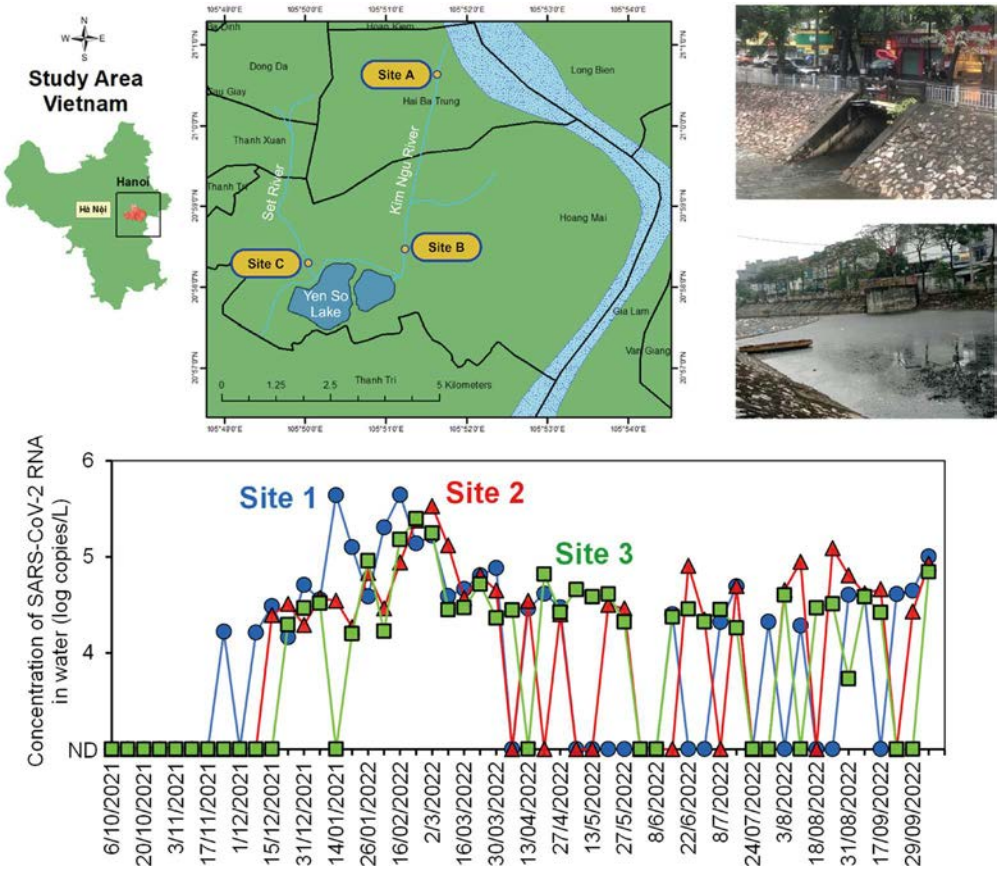

Figure 5. Results of WBE for COVID-19 in Vietnam[1)]

tional tourists, demonstrating that early detection of SARS-CoV-2 variants could be possible within about 3 weeks after its entry into the country.

In Nepal, WBE was conducted at two WWTPs in the Kathmandu Valley. Although the positive ratio of SARS-CoV-2 was low at 44% in the early stage of the wave, the positive ratio increased to 89% around the peak of the wave, and an increase in viral concentration was also observed. In addition to SARS-CoV-2, influenza A viruses and RS viruses were also tested, showing that WBE is effective for a wide range of respiratory diseases.

Cross-country studies have also been conducted. WBE was conducted in four countries (Indonesia, Thailand, the Philippines, and Vietnam) mainly for hand-foot-and-mouth disease (HFMD), which causes a bullous rash on the mouth, hands, and feet mainly in infants and young children. In this study, four major enteroviruses causing HFMD (enterovirus A71 and coxsackievirus types A6, A10, and A16) were tested, and differences in detection ratios were found among the countries. Furthermore, WBE for hepatitis A and E was conducted in all six countries, and hepatitis A virus was detected in 51% of wastewater samples from Nepal, while hepatitis E virus was detected in the highest positive ratio in Japan, suggesting that more people infected with hepatitis E may exist in Japan than is currently known (Figure 6). By using the same detection method, we were able to make comparisons among countries and clarify the prevalence of infectious diseases that differ from country to country.

In order to be able to share and utilize the WBE data of various pathogens obtained in this project with policymakers, a WBE map was created so that data from different countries can be viewed on the same platform (Figure 7). It is expected that WBE incorporating the WBE map can be applied to disaster risk management.

3.3 Training of young researchers

One of the major achievements of this project is that we have focused on fostering young researchers who will lead the next generation in order to make the

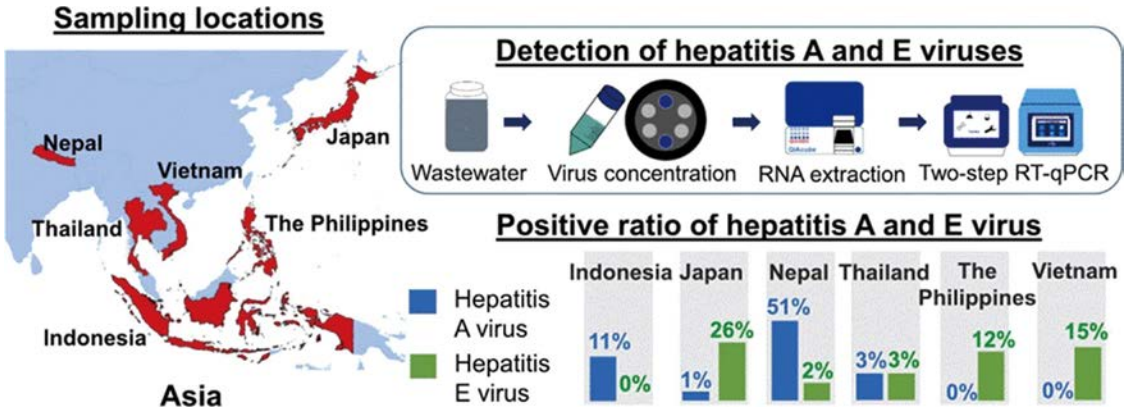

Figure 6. Results of WBE for hepatitis A and E in six Asian countries[2)]

Figure 7. WBE map created in this project

results sustainable. One is to accept young members of the counterpart countries as MEXT scholarship students at University of Yamanashi, including two students from Institut Teknologi Bandung in Indonesia and one each from Walailak University in Thailand and De La Salle University in the Philippines. The second was to dispatch young researchers of Japan group, mainly graduate students, to the counterpart country, where they stayed for about one month and worked on water sampling and laboratory work in cooperation with members of the counterparts. During the project period, seven students visited Thailand, Indonesia, Nepal, and the Philippines a total of 20 times.

4. Main Publications and Conference Presentations

The results of WBE in the countries were compiled and disseminated as peer-reviewed papers and conference presentations. We published seven peer-reviewed papers: six in Science of the Total Environment and one in Journal of Disaster Research. In addition, six oral presentations and four poster presentations were made at international conferences, and three of them received the Best Presentation Award.

Prof. Haramoto and Prof. Kitajima received the 5th Japan Research Front Award in May 2024 as researchers recognized for their activities and contributions in the advanced research area (Research front) “Wastewater-based epidemiology,” which is determined based on the citation status of the top 1% most cited papers in each research field (highly cited papers) in the Web of Science, an academic paper database provided by Clarivate. Prof. Haramoto and Prof. Kitajima received Awards for Science and Technology (Research Category) and the Young Scientists’ Award, the Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, respectively. Furthermore, members of the Thai group led by Dr. Sirikanchana received the “Thailand National Research Award” from the National Research Council of Thailand.

Peer-reviewed papers (7 papers)

1. Sangsanont et al. (2022) Wastewater monitoring in tourist cities as potential sentinel sites for near real-time dynamics of imported SARS-CoV-2 variants. Science of the Total Environment. 860:160317 (2022). [Japan, Thailand]
2. Shrestha et al. (2024) Detection of enteroviruses related to hand foot and mouth disease in wastewater of Asian communities. Science of the Total Environment. 912:169375. [Indonesia, Japan, the Philippines, Thailand, Vietnam]
3. Inson et al. (2024) Detection of SARS-CoV-2 and Omicron variant RNA in wastewater samples from Manila, Philippines. Science of the Total Environment. 919:170921. [Japan, the Philippines]
4. Raya et al. (2024) Quantification of multiple respiratory viruses in wastewater in the Kathmandu Valley, Nepal: Potential implications of wastewater-based epidemiology for community disease surveillance in developing countries. Science of the Total Environment. 920:170845. [Japan, Nepal]
5. Takeda et al. (2024) Risk mapping of COVID-19 to create a common operating picture using data from wastewater monitoring. Journal of Disaster Research. 19(2):420-428. [Japan]
6. Raya et al. (2024) Prevalence of hepatitis A and E viruses in wastewater in Asian countries. Science of the Total Environment. 951:175473. [Indonesia, Japan, Nepal, the Philippines, Thailand, Vietnam]
7. Siri et al. (2024) Assessment of environmental factors influencing SARS-CoV-2 in Vietnam's surface water across two years of clinical data. Science of the Total Environment. 957:177449. [Indonesia, Japan]

Oral presentations (6 presentations)

1. Takeda et al. (2023) Towards an Asian regional framework for wastewater-based epidemiology. 14th International Academic Consortium for Sustainable Cities (IACSC) 2023. [Japan]
2. Haramoto (2023) Implementation of wastewater-based epidemiology for monitoring the incidence of COVID-19 and other infectious diseases in communities. VANJ Conference 2023. [Japan]
3. Kitajima (2023) Wastewater-based Epidemiology for COVID-19 and Other Infectious Diseases. IWIC-WEN 2023. [Japan]
4. Raya et al. (2024) Surveillance of hepatitis A virus in Asian countries using wastewater-based epidemiology. 8th International Society for Food and Environmental Virology (ISFEV) Conference. [Indonesia, Japan, Nepal, the Philippines, Thailand, Vietnam]
5. Takeda et al. (2024), Towards a regional framework for wastewater-based epidemiology. Singapore International Water Week 2024. [Indonesia, Japan, Nepal, the Philippines, Thailand, Vietnam]
6. Angga et al. (2024) Future research prospect of wastewater-based epidemiology in Indonesia: Identification of pathogenic bacteria at wastewater treatment plant in Bandung City. 14th International Symposium on Southeast Asian Water Environment (SEAWE-14). [Indonesia, Japan]

Poster presentations (4 presentations)

1. Inson et al. (2023) Detection of SARS-CoV-2 and Omicron variants in wastewater from various locations in the city of Manila, Philippines. Water and Environment Technology Conference Online 2023. [Japan, the Philippines]
2. Ruti et al. (2023) Pathogenic bacteria identification by quantitative PCR at wastewater treatment plants in Bandung City, Indonesia. Water and Environment Technology Conference Online 2023. [Indonesia, Japan] [WET Excellent Presentation Award]
3. Raya et al. (2023) Quantification of multiple respiratory viruses in wastewater in Kathmandu, Nepal: potential implication of wastewater-based epidemiology for community disease surveillance. Water and Environment Technology Conference Online 2023. [Japan, Nepal] [WET Excellent Presentation Award]
4. Sirikanchana et al. (2024) Multivirus surveillance of emerging and endemic viral pathogens in Thailand's wastewater. 8th International Society for Food and Environmental Virology (ISFEV) Conference. [Japan, Thailand] [Best Poster Presentation Award]

5. Future Challenges, Prospects, and Recommendations

Through this project, we succeeded in demonstrating that WBE is effective in Asian countries, and also clarified various issues that need to be addressed in order to ensure sustainable social implementation of WBE. Although the issues differ from country to country, international cooperation is essential to solving them, and it is expected that the network established through this project will be utilized in the future to spread WBE to other Asian countries as well.

References

1) Siri et al. (2024) Assessment of environmental factors influencing SARS-CoV-2 in Vietnam's surface water across two years of clinical data. Science of the Total Environment. 957:177449. https://doi.org/10.1016/j.scitotenv.2024.177449.
2) Raya et al. (2024) Prevalence of hepatitis A and E viruses in wastewater in Asian countries. Science of the Total Environment. 951:175473. https://doi.org/10.1016/j.scitotenv.2024.175473.

International Symposium on Hitachi Fund Support for Research Related to Infectious Diseases: Edited Remarks by the Chairperson of the Selection Committee

Monte Cassim
President, Chair of the Board
Professor
Akita International University

First of all, I believe everyone here, having heard these incredibly stimulating presentations, must be feeling as excited as I am. What really struck me was not just intellectual exercise, but a profound sense of mission—to contribute to society in a meaningful way. I deeply appreciate the significant contributions of The Hitachi Global Foundation and the entire Hitachi Group, who decided to establish this fund in response to the pandemic. As the chairperson of the selection committee, my role is primarily to observe and support after the selection process is complete. However, after listening to each group's presentations, I would like to share some comments on what we heard. I will start in reverse order from the presentation sequence.

First, regarding the presentations by Professors Haramoto and Kitajima, I was reminded that my own university is also a residential campus, which naturally tends to be prone to clusters. Considering how to prevent infections in such an environment, I believe it is best to start initiatives at large campuses, where various experiments and monitoring can be conducted extensively. From there, it would be ideal to gradually expand these efforts to society at large. Since universities hold a neutral position, unlike private companies where comparisons like "Company A vs. Company B" arise, evidence produced and disseminated by trusted academic institutions can garner wider support and consensus. I am hopeful that such efforts will lead to involvement from ODA and collaboration with governments worldwide, allowing for broader impact.

Moreover, Professor Haramoto, based in Yamanashi, and Professor Kitajima, formerly from Sapporo and now in Tokyo, are both excellently positioned as hubs for outreach. With students involved as well, the next generation can be nurtured, which makes me excited about the potential for expansion. I sincerely hope that both of you will actively continue your efforts, building on this momentum. Thank you very much for conducting this research.

Next, regarding Dr. Hanai's presentation: I recall posing some tough questions during the previous interim report session as chairperson, so I am pleased to see that your answers this time have been even more thorough. What impressed me most through your presentation is the strong "sense of mission" shared by all researchers selected for this infectious disease project. Even amidst armed conflicts, the determination to persevere with one's work—"this must be done!" —is vital for researchers.

I myself have experience working in Sri Lanka during civil unrest, where, as a neutral researcher, I had to devise ways to advance research regardless of who was involved. Through this project, I feel your team exemplifies remarkable resilience as researchers.

Another point that stood out was the deep connection between "health" and "trust." Research that collects data without trust risks losing its essence. I sensed your team's careful and respectful engagement with this issue.

For example, near my university, there is a depopulated mountain village with an aging population. A physician involved there told me that notes written by university students who visited the community were far more useful than information gathered by dispatched public health nurses. When I asked, "But students aren't experts, right?" I was told, "When public health nurses come, residents treat them as government officials and are reluctant to open up, but when students come, residents feel as if their grandchildren have come and open their hearts." This shows

how crucial trust is in gathering health-related information. Your team's respect for this trust left a strong impression on me.

Turning to Professor Tanaka's presentation from Waseda University, in today's society, where SNS is widespread and generative AI blurs, we are entering an era where it is increasingly difficult to judge whether something was created by a human or to determine by whom it was created, while information alone tends to spread rapidly. Distinguishing truth in such an environment is a critical challenge, and I felt your research admirably identifies foundational factors in this regard. As your work is still in progress, I encourage you to continue your efforts to enlighten us further.

Personally, I sense society is becoming somewhat unstable, partly because guaranteeing credibility has become more difficult than before. Your presentation made me reflect on how we can build foundations in this modern context, a challenge important for both mass media and personalized media alike. I believe human society is at a turning point.

One strong impression I took from this entire session is that you are forming an academic "community." Whereas mass media once served as the primary framework, now society is personalized, with "personalized aggregation" becoming fluid rather than fixed communities.

In data science, there is talk of "homomorphic communities"—groups with similar values and mental frameworks that share important information only within trusted circles. How such homomorphic communities relate and interact, even across geographical distances, resonates with how you collaborate with research partners domestically and internationally. I believe that this foundation is built on your shared sense of mission, scholarship, trust, and friendship. By cherishing these values, I am hopeful that concerns like those raised by Professor Tanaka can be overcome.

Regarding Professor Kaneko's presentation, I was reminded that while advanced countries tend to respond quickly to crises, emerging or economically disadvantaged nations often respond slowly. Additionally, when one problem becomes prominent, others may be overlooked. Highlighting the ongoing spread of malaria in Africa was important, as this reflects challenges not only in pandemics but also in conflicts such as the Ukraine war, where nearby crises drew immediate attention, whereas others, like the Iran-Iraq war or even more the Rwandan genocide, were neglected for some time.

These disparities touch on fundamental human sensitivities. To truly pursue a "One World," we need to level these situations more fairly. The sense of mission evident in your presentations is deeply meaningful in this context. How can we spread this sense of mission worldwide? Your efforts to illuminate ideals rather than conflicting interests or power dynamics hold great significance.

From the presentations by Professors Kaneko, Suzuki, and Kamae, I sensed a shared focus on how COVID-19 has affected human health. However, I would argue that this focus extends beyond that—to planetary health.

The pathogens in question this time are zoonotic infections, looking at why and how such pathogens emerge and spread. Although there are conspiracy theories, the fundamental background that makes the emergence of pandemics more likely is the loss of biodiversity. While the corporate sector has begun responding to climate change relatively early, biodiversity loss has yet to receive sufficient attention. Corporate involvement is essential in advancing this research, and I look forward to continued leadership from President Naito (at the time) in fostering these values.

Another interesting aspect is the human tendency to pay attention only after a problem arises. This mechanism is scientifically validated. For example, a study published in Nature more than a decade ago warned of pandemic risks but went largely unnoticed until 2020, when interest skyrocketed. This shows that humans tend not to act preemptively. Yet you have translated your intellect into action—a model that should be promoted throughout society.

From Professors Suzuki and Kamae's presentation, I also sensed that research seemingly unrelated to current problems can actually connect to preventive intervention ("pre-emption"). For example, the mechanism of zoonotic spread is straightforward: large animals disappear, viruses transfer to smaller animals that multiply rapidly and invade human society. That is why such viruses easily infect the human body. Such evidence has been documented by researchers like Dr. Felicia Keesing in disease ecology, and others like Dr. Thomas Efferth at Johannes Gutenberg University. The latter is a planetary health researcher who uses artemisinin to alleviate a range of human health conditions. Your activities in establishing connections with such researchers around the world, along with the launch of this project by The Hitachi Global Foundation, are sowing the seeds of a movement. As a selection committee member, I would like to ask you to think about what can be done locally to expand this widely across the planet.

Finally, a personal suggestion from me: while I assume that The Hitachi Global Foundation will prepare its final report for the board of directors, why not transform it from a mere report into an official publication with an ISBN? Archiving your diverse and vital "seed-sowing" research as a publication, perhaps in collaboration with renowned academic societies, would leave a lasting record of how Japanese and international researchers cooperated to present this knowledge immediately after the pandemic began. I encourage the Foundation to explore this possibility with the input from presenters today. Although its feasibility is yet unknown, I believe this collaborative approach will create a better outcome. Your cooperation in this would be greatly appreciated.

To be frank, at the project's outset, I imagine all selection committee members, including myself, struggled with how to organize the overwhelming volume of applications and reach satisfactory conclusions. But having now heard your presentations, I truly feel it was worth the effort. I deeply thank you, on behalf of the selection committee, for your inspiring presentations and for working to leave something meaningful for future generations. I wish you all continued success and will conclude my remarks here. Thank you very much.

Afterword

Hideaki Shiroyama
Professor
Graduate Schools for Law and Politics
The University of Tokyo

This report compiles the outcomes of five research projects supported by The Hitachi Global Foundation's "Hitachi Fund Support for Research Related to Infectious Diseases". Each of these projects embodies distinctive characteristics, which are outlined below.

First, the projects were conducted with a medium-term perspective, spanning from December 2021 to November 2024, in parallel with the emergence of the COVID-19 pandemic and the subsequent development of countermeasures since 2020. As a result, the research did not merely address short-term practical challenges but also provided a comprehensive analysis of issues that became apparent during the pandemic, drawing medium-term lessons. For example, "The International Joint Study on Public Health Economics and Value Assessment of Prevention in Pandemic", led by Professor Suzuki, attempted to objectively evaluate the balance between healthcare and economic measures during lockdowns, the effectiveness of testing strategies, and the impact of vaccination.

Second, although the fund was established in response to the COVID-19 pandemic, and its scope extends beyond COVID-19 to wide range of infectious diseases in general, allowing for a broad exploration of various risks. For instance, the project titled "Malaria Eradication in the Era of the COVID-19 Pandemic", led by Professor Kaneko, conducted a comprehensive analysis of the effectiveness of insecticide-treated ceiling nets, as well as economic and educational interventions aimed at promoting behavioral change, with a focus on malaria-a longstanding public health issue, particularly in Africa. Similarly, the project titled "Implementing Wastewater-based Epidemiology in Asian Communities to Strengthen Resilience against Pandemics", led by Professor Haramoto, developed systems for monitoring the spread of various infectious diseases, including COVID-19, through wastewater surveillance, and promoted the transfer of these technologies. The surveillance targeted not only the novel coronavirus but also other pathogens such as norovirus and Salmonella.

Third, the diversity of responses to the COVID-19 pandemic across various political and social contexts around the world was brought to light. For example, the project titled "COVID-19 and Society", led by Professor Tanaka, investigated risk perceptions in ten countries. It includes comprehensive study between Japan and China on the role of experts in media coverage and the dissemination of COVID-19-related information through social media. Based on these comparisons, several fundamental governance challenges in Japan's response to COVID-19 were identified, including scientism, a reliance on technological solutions, and a deficit model of citizen engagement. Furthermore, the project titled "Exploration of Practical Wisdom and Resilience Overcoming Downside Risk", led by Dr. Hanai, highlighted the existence of risk trade-offs in sub-Saharan African countries—namely South Africa, Uganda, Zimbabwe, the Democratic Republic of Congo, Kenya, Tanzania, and Ethiopia—where COVID-19 countermeasures resulted in increased risks of other infectious diseases and hunger. The study also revealed the influence of misinformation on vaccination behavior and the politicization of infectious disease control—for example, the perception of successful pandemic response due to lower-than-expected infection rates, which led to increased public approval of governments.

Looking ahead, it is hoped that the broad lessons learned from the COVID-19 pandemic will contribute to better preparedness for future pandemics.

Appendix: List of Research Projects Supported by the Hitachi Fund Support for Research Related to Infectious Diseases

Research Type	Project Name	Grant Period	Grant Amount	Principal Researcher
Comprehensive Research	International Joint Study on Public Health Economics and Value Assessment of Prevention in Pandemic – Lessons Learned from COVID-19 and Evidence-Based Recommendations for Future Crisis	from December 1, 2021 through November 30, 2024	50 million yen	(from December, 2021 through March, 2023) Akio Onishi Visiting Professor, Graduate School of Public Policy, The University of Tokyo (from April, 2023 through November, 2024)* Hiroshi Suzuki Professor, Graduate School of Public Policy, The University of Tokyo
Field Expanding Research	Malaria Eradication in the Era of COVID-19 Pandemic: a Study Integrating Sociological, Economic, and Medical Approaches to Overcome the Challenges in Tropical Africa	from December 1, 2021 through November 30, 2024	30 million yen	Akira Kaneko Specially Appointed Professor, Osaka International Research Center for Infectious Diseases, Graduate School of Medicine, Osaka Metropolitan University Professor, Karolinska Institutet
Field Expanding Research	Covid-19 and Society: Comparative Analysis of Risk Communication, Expertise, and Citizenship	from December 1, 2021 through November 30, 2024	30 million yen	Mikihito Tanaka Professor, Faculty of Political Science and Economics, Waseda University
Field Expanding Research	Exploration of Practical Wisdom and Resilience Overcoming Downside Risk -Collecting Grassroots Voices in Africa under COVID-19	from December 1, 2021 through November 30, 2024	30 million yen	Kazuyo Hanai Project Assistant Professor, Institute for Future Initiatives, The University of Tokyo
Field Expanding Research	Implementing Wastewater-Based Epidemiology in Asian Communities to Strengthen Resilience against Pandemics	from December 1, 2021 through November 30, 2024	29.99 million yen	Eiji Haramoto Professor, Interdisciplinary Center for River Basin Environment, University of Yamanashi

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