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Science in action for safer food: World Food Safety Day 2025

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The global public health community observes the annual World Food Safety Day on 7 June under the auspices of the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). The 2025 theme, "Food Safety: Science in Action", emphasizes the role of science in identifying food safety hazards, preventing foodborne illness and guiding decision-making from farm to fork.

Since its launch in 2019, World Food Safety Day has become a vital global platform for raising awareness and mobilizing action on food safety. Its objective is to engage governments, the private sector, academia and civil society in promoting food safety education, policy dialogue and community involvement. These efforts seek to prevent, detect and manage foodborne risks, contributing to food security, public health, economic growth, agricultural development, market access, tourism and sustainable development. World Food Safety Day has strengthened cross-sector collaboration, encouraged the enhancement of national food safety systems and supported the adoption of Codex Alimentarius international food standards through science-based approaches.

This year, FAO and WHO have released a World Food Safety Day 2025 campaign launch video, communications tools, campaign materials and more to help countries and stakeholders organize awareness activities such as educational campaigns, exhibitions, quizzes and webinars.[1] These events aim to engage the public, promote cross-sector collaboration and emphasize that safe food is a shared responsibility.

Food safety is crucial for public health, food security and economic development and is a shared responsibility across the supply chain – from producers to consumers. Science-based practices and established standards are essential to prevent food contamination and ensure food safety. Scientific evidence identifies hazards, informs risk management, and guides policy-makers, businesses and the public. It also supports evidence-based policy decisions, promotes good hygiene practices in food operations, and encourages safer consumer behaviours.[2] For example, scientific risk assessments of microbial contamination in fresh produce have led to safety standards, improved market hygiene and better public handling practices in the Western Pacific Region. Without science, food safety maintenance in global supply chains would be impossible.

According to WHO, 125 million people fall ill and over 50 000 die annually in the Region from unsafe food. Children aged <5 years are particularly affected, accounting for 30% of foodborne illness cases and 7000 deaths each year.[3] These statistics underscore the need for stronger food safety systems, especially in low- and middle-income countries with inadequate regulation, poor infrastructure, limited surveillance and low consumer awareness.[4]

In the Region, the coexistence of diverse food production systems, reliance on food imports and traditional food markets together with rapid urbanization necessitates the integration of scientific advances into food safety policies and practices. Governments are encouraged to invest in laboratory capacity, food safety education, early warning systems and regional information exchange. The private sector, academia and civil society also play vital roles in advancing and applying scientific knowledge.[5]

The Regional Framework for Action on Food Safety in the Western Pacific,[5] endorsed by the WHO Regional

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Committee in 2017, recognizes the evolving landscape of food safety and redefines strategies for strengthening national food safety systems. It emphasizes building public trust and confidence, while promoting strategic actions that foster leadership, partnerships, capacity and resource mobilization, all of which are key enablers for advancing food safety. Aimed at national food safety authorities, the Framework offers guidance on strategic planning and a science-based, step-by-step approach to manage food safety risks effectively and respond to incidents and emergencies.

Ultimately, food safety is a shared commitment to health, equity and sustainability. On World Food Safety Day 2025, WHO reaffirms the importance of science and evidence-based data for prevention, protection and progress. By translating scientific knowledge into action, WHO can strengthen food safety systems, reduce the incidence of foodborne illness and contribute to a healthier future for all.

Acknowledgement

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Conflicts of interest

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Ethics statement

Ethical clearance was not required. No personal identifiable information was collected or reported.

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Experience conducting COVID-19 vaccine effectiveness studies in response to the COVID-19 pandemic in Japan and the Philippines: lessons for future epidemics and potential pandemics

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Problem: Once COVID-19 vaccines were rolled out, there was a need to monitor real-world vaccine effectiveness to accumulate evidence to inform policy and risk communication. This was especially true in Japan and the Philippines, given historical issues that affected vaccine confidence.

Context: Neither country had public health surveillance that could be enhanced to evaluate vaccine effectiveness or readily available national vaccination databases.

Action: Study groups were established in multiple health-care facilities in each country to assess vaccine effectiveness against both symptomatic infection and severe disease.

Outcome: In Japan, multiple study reports were published in Japanese on the website of the National Institute of Infectious Diseases and presented at the national government's advisory board. Nationwide media coverage facilitated transparency and increased the confidence of the government and the public in the vaccination programme. In the Philippines, the launch of the study was delayed so as to align the research plan with the interests of various stakeholders and to obtain institutional review board approval. Ultimately, the studies were successfully initiated and completed.

Discussion: There were four main challenges in conducting our studies: finding health-care facilities for data collection; obtaining exposure (vaccination) data; identifying epidemiological biases and confounders; and informing policy and risk communication in a timely manner. Preparedness during inter-emergency/epidemic/pandemic periods to rapidly evaluate relevant interventions such as vaccination is critical and should include the following considerations: (1) the establishment and maintenance of prospective data collection platforms, ideally under public health surveillance (if not, clinical research networks or linked databases); (2) uniform and practical protocols considering biases and confounders; and (3) communication with stakeholders including institutional review boards.

PROBLEM

COVID-19, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has resulted in substantial morbidity and mortality globally. Once vaccines were rolled out, real-world vaccine effectiveness (VE) data were needed to accumulate evidence to inform policy and risk communication.[1] This became more apparent during the early unblinding of randomized controlled trials,[2] together with evidence

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of waning immunity and the emergence of variants with immune escape properties.[3,4] Although the World Health Organization (WHO) did not recommend that all countries conduct VE studies on account of methodological complexity and susceptibility to biases,[5] it was considered valuable for Japan and the Philippines to conduct VE studies for several reasons: (1) historical issues with vaccine confidence in both countries and in neighbouring countries (especially given previous issues that affected vaccine confidence, for example, human papillomavirus and influenza vaccines in Japan[6,7] and dengue vaccine in the Philippines[8]); (2) new vaccine technologies, such as messenger ribonucleic acid (mRNA) vaccines and viral vector vaccines, were rolled out to the general population for the first time and the effects may vary by population subgroup; (3) substantial variation in public health and social measures implemented among countries (which may affect VE estimates[9]); and (4) considerable cumulative burden of infections among different populations (as individuals with prior infection are at least partially protected against subsequent infections and diseases). VE studies in low- and middle-income countries (LMICs) were considered particularly informative for the following reasons: (1) evaluation of vaccines that are mainly distributed in LMICs as part of public health response measures; (2) confirmation that the vaccines remain active through distribution networks (for example, no cold chain breach, as temperature control is especially important for vaccines such as mRNA vaccines); and (3) capacity-building to conduct operational research to inform various public health responses for COVID-19 as well as future epidemics and pandemics.

The authors, together with collaborators established health-care facility-based study groups in Japan and the Philippines to assess VE against symptomatic infection (FASCINATE study) and severe disease (MOTIVATE study).[9–15] This report describes the experience of planning, establishing and executing these VE studies during the COVID-19 pandemic.

CONTEXT

As in other countries, the COVID-19 pandemic substantially affected Japan and the Philippines. The epidemic curve of reported COVID-19 cases and vaccination rollout with selected study milestones in each country are illustrated in **Fig. 1**. In Japan, the primary series rollout started in mid-February 2021, with the first booster dose in December 2021, the second booster dose in May 2022 and the third booster dose (bivalent vaccines) in September 2022. The second booster dose was administered exclusively to individuals who were ≥60 years old, had comorbidities or were health-care or long-term care workers. The majority of the administered vaccines were manufactured by Pfizer-BioNTech and Moderna (99.9% for the primary series).

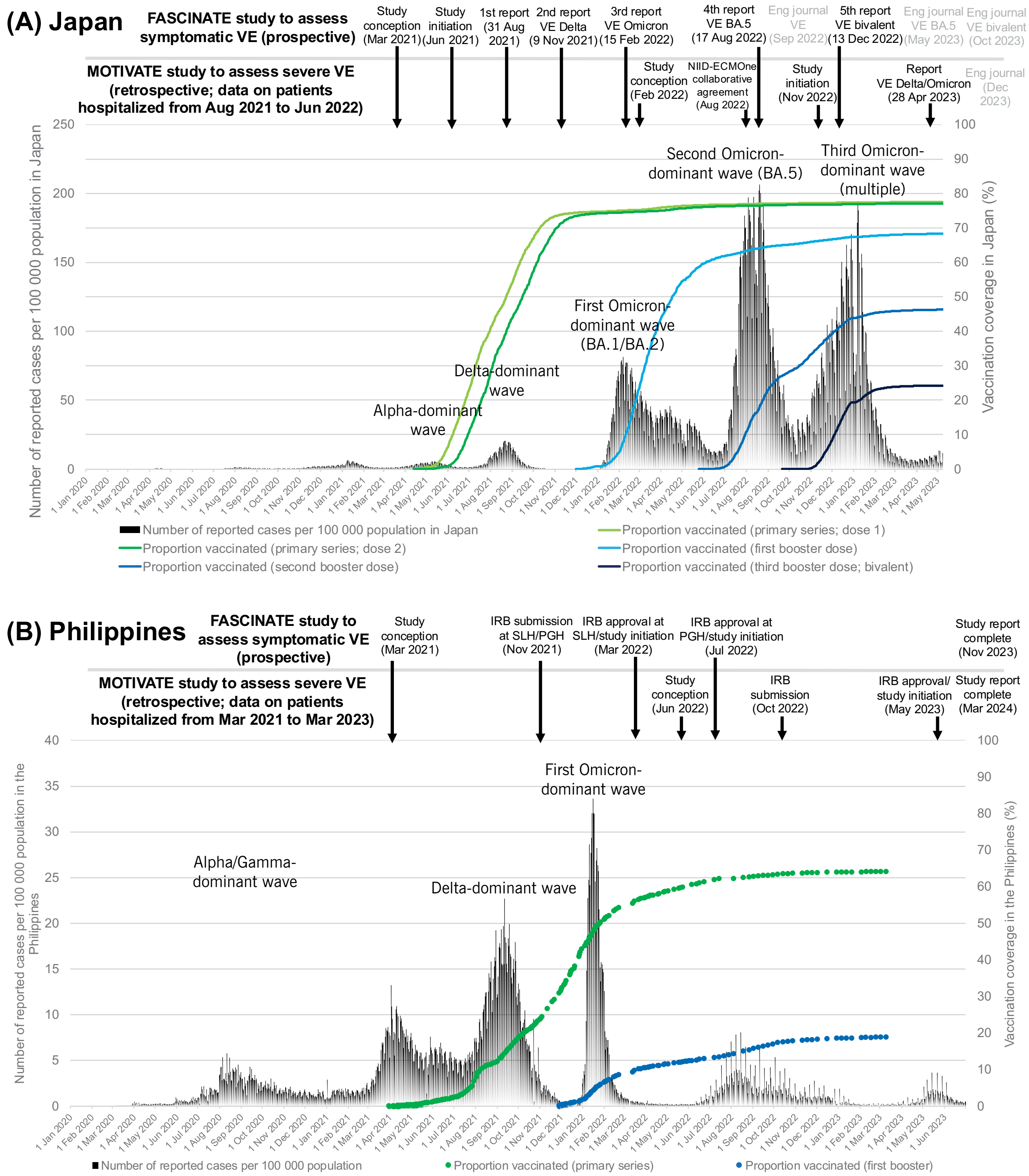
In the Philippines, the primary series rollout started in March 2021. The first booster dose rollout started in November 2021 among health-care workers (HCWs), senior citizens and immunocompromised individuals, and was expanded to adults aged ≥18 years in December 2021. The second booster dose rollout started in April 2022 among HCWs and individuals who were ≥60 years old, and in July 2022 among individuals who were ≥50 years old and those aged 18–49 years with comorbidities. In the FASCINATE study, among the vaccinees for the primary series, 39% received AstraZeneca, 37% received Sinovac, 18% received Pfizer-BioNTech or Moderna, and 6% received other types. Over 90% of the vaccinees received Pfizer-BioNTech or Moderna booster doses.

Existing public health surveillance, such as for influenza-like illness (ILI) and severe acute respiratory infection (SARI), was not easy to enhance rapidly to evaluate VE. Therefore, we collaborated with health-care facilities to set up prospective studies in both countries.

ACTION

Study groups to assess VE against symptomatic infection (FASCINATE study groups) were formed in each country. Mild symptomatic infection was the outcome of choice, as it was the endpoint of the trials. Health-care facilities that routinely testing for SARS-CoV-2 among symptomatic individuals of different ages in the outpatient setting were recruited and the studies were initiated in each country. The FASCINATE study also aimed to elucidate sociobehavioural factors associated with SARS-CoV-2 infection. Subsequently, emerging evidence suggesting that VE wanes against mild symptomatic infection and is also less effective in the Omicron setting resulted in the need to evaluate VE against severe disease. Therefore, additional MOTIVATE study groups were formed and initiated in both countries. For MOTIVATE study groups,

Fig. 1. **Epidemic curves of the number of reported COVID-19 cases and vaccine rollout with study milestones in (A) Japan and (B) the Philippines[a]**



ECMOnet: non-profit organization, Japan; IRB: institutional review board; NIID: National Institute of Infectious Diseases, Japan; PGH: Philippines General Hospital; SLH: San Lazaro Hospital, Philippines; VE: vaccine effectiveness.

[a] The data are probably underestimated due to reporting constraints, testing/reporting intensity varying substantially over time, and COVID-19 vaccination data collection for the Philippines ending on 9 March 2023.

Sources:

Japan: Ministry of Health, Labour and Welfare, Japan (https://www.mhlw.go.jp/stf/covid-19/open-data.html [in Japanese]) and Digital Agency, Japan.

Philippines: Our World in Data (https://ourworldindata.org).

Table 1. **Implementation challenges in conducting VE studies during the COVID-19 pandemic based on experience in Japan and the Philippines**

Implementation challenges	Solutions/mitigations (checkmark [✓] for the ones used and arrowhead [➢] for suggestions for future studies)	Countries
Recruitment of health-care facilities	✓ Search for health-care facilities where testing is done frequently and where patients with COVID-19 and other respiratory infections are admitted frequently ✓ Convey the public health value of the research. ✓ Collaborate with existing clinical networks. ✓ Design the study in a way that the burden of health-care facilities is minimal. ➢ Establish a unified database that can link vaccination records and outcomes may minimize/eliminate the need to do this.	Both (especially Japan)
Unavailability of vaccination record database	✓ Refer to either vaccination card or medical chart (if neither is available, self-report). ➢ Establish a unified database for vaccination records.	Both
Epidemiological biases and confounders (see **Table 2** for a specific list)	✓ Be careful and agile in consideration of biases and confounders. ➢ Ensure clear case definition and collection of essential information such as relevant potential confounders (best done as a prospective study by ideally incorporating into public health surveillance, such as ILI or SARI surveillance). ➢ Prepare uniform and practical protocols that can be adopted rapidly if a health emergency occurs. See **Table 2** for specific solutions/mitigations for each bias or confounder.	Both
Timeline	✓ Communicate with various stakeholders including institutional review board secretariat/members regularly. ➢ Establish/maintain platforms such as clinical research networks and unified databases during inter-emergency/epidemic/pandemic period. ➢ Conduct studies as public health activities rather than research (if feasible under local circumstances). ➢ Append VE evaluation component to existing public health surveillance such as ILI or SARI surveillance. ➢ Prepare uniform and practical protocols that can be pre-approved and then rapidly adopted when a health emergency occurs. ➢ Establish a mechanism to publish and disseminate study results rapidly.	Both (especially the Philippines)
Maintaining motivation of health-care facilities	✓ Periodically communicate and publish findings to acknowledge contributions.	Japan
Infection prevention and control measures in health-care facilities	✓ Show evidence that the virus can be inactivated on paper after several days. ✓ Design the study in a way that the burden of health-care facilities is minimal.	Both
Human resources	✓ Seek support from medical students who are eager to gain research experience. ➢ Establish ways to build surge capacity.	
Funding	✓ Publishing multiple reports resulted in further funding (Japan). ✓ The World Health Organization provided funding (the Philippines).	Both

ILI: influenza-like illness; SARI: severe acute respiratory infection; VE: vaccine effectiveness.

health-care facilities that routinely admitted individuals with COVID-19 and pneumonia due to other etiologies (for example, bacterial pneumonia) were recruited. We examined VE against various severe outcomes, including oxygen use, invasive mechanical ventilation use and death. We also collected data on whether medical intervention, such as oxygen use, was due to COVID-19 or other diseases among those who tested positive for SARS-CoV-2.

OUTCOME

In Japan, the study prompted the publication of multiple study reports in Japanese on the National Institute of Infectious Diseases (NIID) website. They were also presented at the national government's advisory board to inform policy and risk communication (**Fig. 1**). Since NIID is part of the Ministry of Health, Labour and Welfare (MHLW) in Japan, authorization was obtained

Table 2. **Biases and how to approach them in conducting VE studies during the COVID-19 pandemic based on experience in Japan and the Philippines**

Epidemiological biases and confounders	Problem	Approach to reduce biases/confounders (checkmark [✓] for the ones used and arrowhead [➢] for suggestions for future studies)
Potential confounding factors known at the beginning of the study	Potential confounding factors include age, sex, race/ethnicity, socioeconomic status, occupation, chronic medical conditions, close contact history, onset date, and priority groups for vaccination.	✓ Adjust for confounders.
Diagnostic bias	Health workers are more likely to test certain populations such as unvaccinated individuals or individuals at high risk of severe COVID-19.	✓ Ask health workers to decide not to test based on vaccination or other status. ✓ Use specific case definition for study inclusion.
Misclassification of the outcome	False positives and false negatives	✓ Use PCR that has high sensitivity and specificity. ✓ Use more specific and severe outcomes. ✓ Restrict to individuals with symptom onset within 2 weeks.
Misclassification of the exposure	Wrong vaccination data	✓ Ascertain vaccination history with vaccine card/certificate. ➢ Establish a unified database that can link vaccination records and outcomes such as hospitalizations.
Prior infection	• Prior infection may partially protect against subsequent infection, resulting in an underestimate of VE. • Individuals with known prior SARS-CoV-2 infection are less likely to get vaccinated.	✓ Adjust for prior infection. ➢ Perform sensitivity analysis excluding those with prior SARS-CoV-2 infection. ➢ Account for underascertainment of prior infection, which can result in residual bias (exploratory use of infection-specific serology may help mitigate this).
Spurious waning	An ever-increasing pool of unvaccinated individuals become immune through infection, resulting in a progressively increasing underestimate of VE, giving the appearance of waning.	➢ Conduct the study in a short period of time before the epidemic peak. ➢ Enrol only those without prior infection.
Vaccination certificate/passport policy (for domestic purposes)	Vaccination passports allow vaccinated individuals to engage in high-risk behaviours, such as going to restaurants and bars, while keeping unvaccinated individuals from such activities, resulting in an underestimate of VE (or even negative VE).	✓ Adjust for risk behaviour status.
Differential risk behaviour based on vaccine status	Vaccinated individuals are more likely to engage in high-risk behaviours, such as going to restaurants and bars, as they feel protected, resulting in an underestimate of VE (or even negative VE).	✓ Adjust for risk behaviour status.
Incidental infection among individuals hospitalized with unrelated conditions	If SARS-CoV-2 testing at hospital admission is done for individuals without COVID-19-like symptoms in the setting of high transmission, this will result in an underestimate of VE (given lower VE against infection compared to hospitalization).	✓ Use more specific and severe outcomes, such as oxygen or mechanical-ventilation use or, ideally, to restrict individuals who are hospitalized specifically for COVID-19.
Care-seeking and testing behaviour; changes in testing strategies	• Vaccinated persons are less likely to seek care/testing for COVID-19-like illness due to the perception of protection, resulting in an overestimate of VE. • Changing testing strategies (e.g. after Omicron, testing became less frequent in many countries) can affect results.	✓ Breakthrough infection is common enough that individuals should be encouraged to get tested even after vaccination. ➢ Make sure the testing strategy remains stable (such as by prospective study design).
Bias due to co-circulation of influenza, RSV or *Streptococcus pneumoniae* and COVID-19	Co-circulation of influenza, RSV or *Streptococcus pneumoniae* and COVID-19 can result in biased VE estimates as propensity to get vaccinated may be similar for COVID-19 vaccines and influenza/pneumococcal vaccines.	✓ Exclude influenza/RSV/*Streptococcus pneumoniae* cases or adjust for influenza vaccination/pneumococcal vaccination status.

Epidemiological biases and confounders	Problem	Approach to reduce biases/confounders (checkmark [√] for the ones used and arrow-head [➢] for suggestions for future studies)
Other residual confounders and biases	Other potential residual confounders and biases.	➢ Restrict the study population to a particular population group, such as health-care workers, whose sociodemographic factors are similar between the vaccinated and unvaccinated.

PCR: polymerase chain reaction; RSV: respiratory syncytial virus; VE: vaccine effectiveness.

from the MHLW before publication. Published findings were disseminated via multiple nationwide news media platforms, increasing the confidence of the government and the public in the vaccination programme. This continued until the transition to the endemic phase in May 2023. In the Philippines, due to the delay in initiating the study, the report became available in November 2023 for the FASCINATE (outpatient) study and in March 2024 for the MOTIVATE (inpatient) study.

DISCUSSION

Many challenges in conducting VE studies were encountered in both countries (**Table 1**). Here, four main challenges are highlighted. The first challenge was identifying health-care facilities willing to participate in the study. HCWs were working around the clock in response to the pandemic, and any additional work was often not possible. In Japan, the authors contacted the health-care facilities directly to seek cooperation. In total, 16 clinics and hospitals for the FASCINATE study and 29 hospitals for the MOTIVATE study agreed to join. Specifically, for the MOTIVATE study in Japan, NIID and ECMOnet (a non-profit organization formed by critical care physicians) successfully collaborated to identify health-care facilities.[13] In the Philippines, the FASCINATE study was conducted in two hospitals, while the MOTIVATE study was a single-centre study.

The second challenge was that there was no national database of vaccination records. Therefore, such data were collected at each health-care facility (using either a vaccination card, medical chart or self-report[16]). However, collecting accurate vaccination histories can be resource-intensive, as described in this report. This was a disadvantage compared to some other countries, such as United Kingdom of Great Britain and Northern Ireland, where such data were readily available. However, we saw this as an opportunity to assess VE in an accurate manner by prospectively collecting data that were not readily available and by being able to set a clear clinical case definition to reduce bias caused by unclear definitions. Specifically, for the FASCINATE study, we collected past behavioural data such as attendance at social gatherings that could potentially have been associated with both exposure (for example, the likelihood of vaccination or change in behaviour post-vaccination) and outcome (the likelihood of infection). In fact, the FASCINATE study also aimed to elucidate sociobehavioural factors associated with SARS-CoV-2 infection, which turned out to be important in adjusting for potential biases.[9] For the MOTIVATE study, we collected data on whether medical intervention, such as oxygen use, was due to COVID-19 or other diseases among those who tested positive for SARS-CoV-2,[13] since incidental infection found at the time of hospital admission with unrelated conditions was an issue in using a database to conduct VE studies.[17]

The third challenge was that of evolving epidemiological biases and confounders (**Table 2**). Due to the prospective nature of the study, we were able to mitigate the majority of these, but the risk of residual bias was considered high in the Philippines study results. A reason for this included the likelihood that most unvaccinated individuals were infected before the study's initiation (which was immediately after the first Omicron surge, which probably afforded better protection compared to vaccination several months earlier, and differential sociodemographic and risk behaviour status between the vaccinated and the unvaccinated.

The final challenge was the timeline. There was a substantial delay in study initiation in the Philippines. What took time was the alignment with various stakeholders and institutional review board (IRB) approval. Following IRB approval, a memorandum of agreement as well as a non-disclosure agreement needed to be signed and validated by the hospital's legal department with apostille required. Recruitment was also a challenge, as the investigation started right after the Omicron surge. In Japan, we were able to initiate the study and publish reports in a relatively timely manner to inform policy and risk communication. However, it was not always possible to respond to the rapidly evolving policy and communication needs, especially on VE against severe disease.

For future epidemics and pandemics, preparedness during the inter-epidemic/inter-pandemic periods will be critical so that interventions such as vaccination can be rapidly evaluated when such health emergencies occur. Based on our experience, we summarized three main lessons learned. First is the importance of establishing and maintaining platforms to rapidly evaluate interventions such as vaccination. Ideally, these would be incorporated into public health surveillance (for example, ILI or SARI surveillance) and carried out via prospective data collection. The prospective approach would ensure a clear case definition and collection of essential information, such as relevant potential confounders. If this is not feasible, clinical research networks such as the International Severe Acute Respiratory and emerging Infection Consortium and/or a unified database that can link exposure and outcome data (as well as genomic characterization of infections) may be considered. Specifically, setting up these platforms and monitoring epidemics, such as seasonal influenza and respiratory syncytial virus infection, during the inter-emergency/pandemic period in advance is critical, as these can rapidly be applied to newly emerging respiratory infections with pandemic potential. The second lesson is the usefulness of uniform and practical protocols with careful and agile consideration of biases and confounders to conduct clinical research based on policy and risk communication needs, which would also allow for cross-comparison of studies. A guidance document on VE studies was published by WHO,[5,17] but it was generic in nature. Therefore, some of the authors at the WHO Regional Office for the Western Pacific prepared a practical protocol, which was used as a basis for a VE study in Viet Nam. The third lesson is the value of communication with all potential stakeholders including IRBs during the inter-emergency/pandemic period to pre-approve generic clinical study protocols that can then be expedited when a health emergency occurs, although incorporating VE evaluation into public health surveillance may eliminate this need.

During health emergencies, responding to the event itself is the priority, and conducting operational studies may seem less important. However, evidence-based decision-making is key to a successful response, and such studies are exactly what inform health emergency response.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Ethics statement

Ethics approval was not required for this report. Ethics approval was obtained for the previous vaccine effectiveness studies discussed in this report.

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Lessons learned from the public health response to chemical pollution in Tebrau River, Johor, Malaysia, 2024

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Problem: In September 2024, an illegal toxic waste dumping incident along the Tebrau River in Johor State, Malaysia, raised widespread health concerns in Johor Bahru and Kulai districts. The pollution released a strong, unpleasant odour, resulting in acute symptoms among exposed individuals, including sore throat, dizziness and coughing.

Context: The Tebrau River is a vital waterway supporting urban populations in Johor. This was not the first chemical pollution event in the region, as previous incidents, including the Kim Kim River crisis in 2019, highlighted the region's vulnerability to such events. The involvement of multiple districts and agencies during the response presented challenges in coordination and data sharing.

Action: The Johor Bahru District Health Office promptly deployed a rapid assessment team to assess the affected areas and implement both active and passive case detection. Community engagement targeted vulnerable populations, such as schoolchildren, to minimize exposure risks. Additional dumping sites identified along the Tebrau River prompted expanded surveillance and a state-level response to coordinate efforts across districts and all health-care facilities.

Outcome: A total of 484 individuals were exposed to the pollution, 334 of whom developed symptoms related to chemical exposure. Timely public health actions consisted of actions to mitigate the impact. Health facilities were placed on high alert and community trust was maintained through proactive engagement. However, gaps in cross-district coordination and challenges accessing environmental data underscored areas for improvement.

Discussion: This incident highlighted the importance of rapid assessment, cross-sector collaboration, community engagement and integrated data systems. It also showed that effective public health action is possible despite environmental data limitations. The strengthening of communication, standardized protocols and real-time data sharing will be critical to improving future chemical pollution events.

PROBLEM

In early September 2024, a chemical pollution incident along the Tebrau River in Johor State, Malaysia, raised widespread health concerns in Johor Bahru and Kulai districts, which are in the southern region of Peninsular Malaysia. On 3 September 2024, residents were exposed to an intense and unpleasant odour emanating from the river, leading to reports of health symptoms commonly associated with chemical exposure. Affected individuals experienced dizziness, sore throat, coughing, difficulty breathing and eye irritation. The health impact was significant, with 484 individuals across the two districts seeking medical attention; 334 developed symptoms, five were admitted to hospital, and the rest were treated as outpatients. Most cases were reported among residents living near the Tebrau River, underscoring the extent of exposure and the vulnerability of communities living near the contamination source. This incident highlighted critical challenges in addressing environmental hazards and protecting public health in urbanized areas.

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CONTEXT

The Tebrau River is a significant waterway that flows through the districts of Johor Bahru and Kulai in Johor State, Malaysia (**Fig. 1**). Spanning approximately 50 km, the river plays a crucial role in sustaining the local ecosystem, supporting natural habitats and providing resources for human populations along its banks. Industrial activities and urbanization in the surrounding areas may exert environmental pressures on the river, raising concerns about potential health risks to nearby populations.

Chemical pollution is not new to Johor, particularly in the Johor Bahru district.[1] The Tebrau River incident marked the largest area affected to date, prompting a coordinated response across multiple districts. In comparison, the 2019 Kim Kim River crisis involved a higher number of people, with over 5000 people – mainly schoolchildren – treated for respiratory symptoms and 111 schools closed due to volatile organic compound (VOC) exposure.[1] However, that incident was confined to a single district. By contrast, the Tebrau River incident spanned several districts, posed greater coordination challenges and required broader cross-agency collaboration. In 2023, the Tiram River was affected by an illegal burning activity that involved suspected chemical waste in the form of solid sludge and liquid discharges, which resulted in widespread pollution. The incident in Pasir Gudang, Johor Bahru, caused localized effects, with 24 schoolchildren and four adults reportedly affected.[2] These recurring incidents demonstrate the persistent vulnerability of waterways in Johor State to industrial and illegal activities, reinforcing the necessity for proactive environmental monitoring and stricter enforcement of pollution control measures.

Johor Bahru and Kulai districts are economically vibrant regions contributing substantially to Johor's development. Johor Bahru, a major industrial and urban hub, hosts diverse industries, including manufacturing, chemical and palm oil processing. Kulai, while smaller, has seen rapid industrialization and urbanization due to its strategic location near major trade routes. The industrial expansion in these districts has come with environmental trade-offs. Industrial discharges, including waste products and chemical pollutants, frequently flow into local water bodies, such as the Tebrau River. While authorities work diligently to enforce regulations under Malaysia's Environmental Quality Act 1974, some industries continue to engage in illegal dumping or fail to adequately manage their effluent, leading to recurrent pollution incidents.

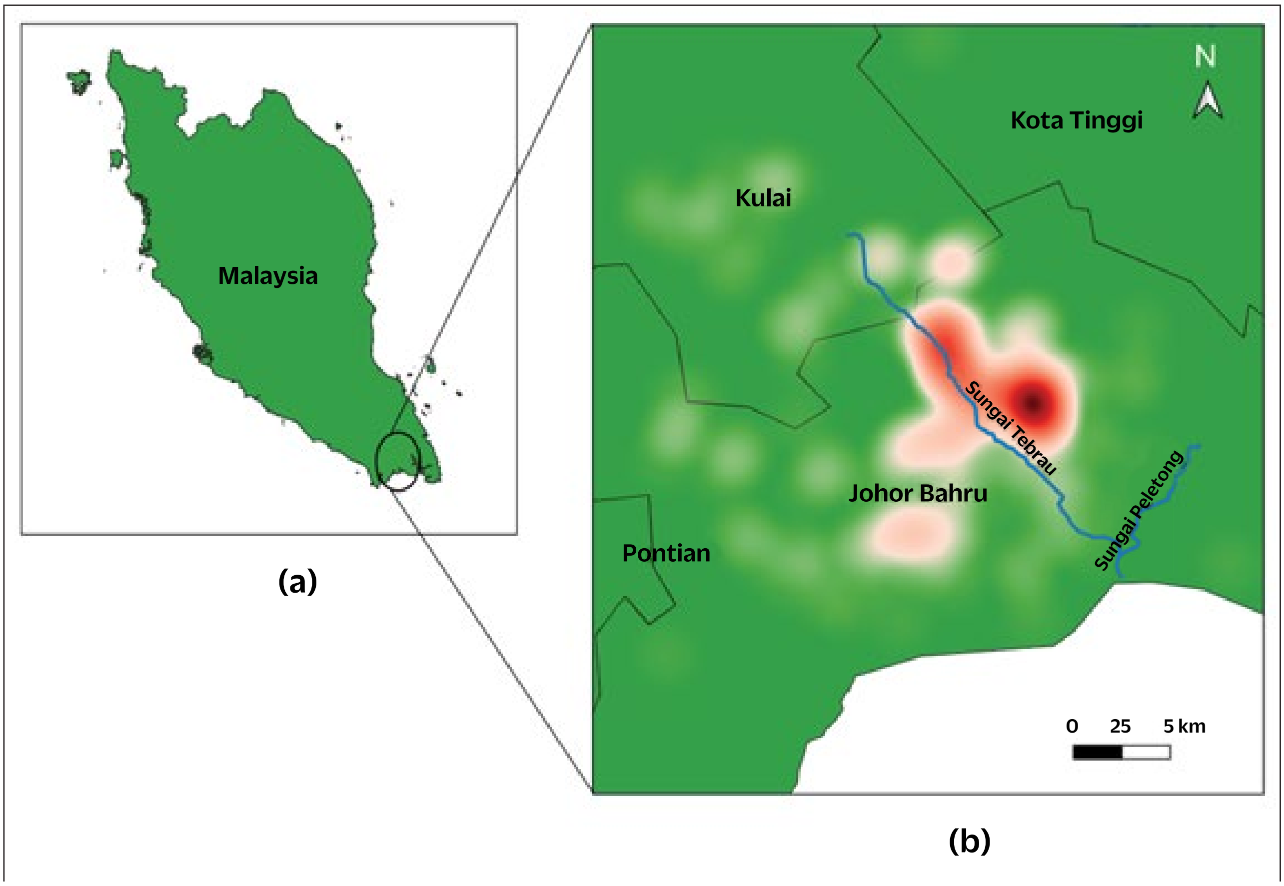
ACTION

Public health response

Following reports of a strong, unpleasant odour emanating from an area approximately 3 km from the Tebrau River, the Johor Bahru District Health Office initiated a multifaceted response. On 3 September 2024, a rapid assessment team (RAT) comprising three environmental health officers was dispatched to the affected area to conduct site evaluations and implement active case detection within the community. The primary objective was to identify individuals exhibiting symptoms commonly associated with chemical exposure, primarily through inhalation, such as sore throat and respiratory difficulties as well as eye irritation. Further investigations, conducted in collaboration with the Fire and Rescue Department and the Department of Environment, led to the suspected presence of VOCs.[1] Community engagement efforts were conducted in the affected areas, including outreach to schools and educational institutions, to provide information and guidance on minimizing exposure, particularly among vulnerable schoolchildren. As part of the response, both active and passive surveillance systems were established to monitor the health impacts and detect potential cases linked to the incident.

On 9 September 2024, a similar odour was reported in Kulai district, located 30 km north of Johor Bahru. Further investigations identified multiple small-scale illegal dumping sites upstream of the Tebrau River in Kulai district, prompting an extension of surveillance and response activities along the entire river. Recognizing the potential scale of exposure, the Johor State Crisis Preparedness and Response Centre (CPRC) was activated to enhance coordination efforts. The CPRC acted as a central hub for communication and data integration within the Ministry of Health, providing a clearer operational picture. This facilitated the rapid reporting of cases and the dissemination of targeted health alerts to health facilities for an effective response. Due to the involvement of multiple locations, logistics for field investigations and data collection were coordinated under the CPRC and were efficiently managed through existing administrative

Fig. 1. **Heatmap showing density of cases within the incident site along the Tebrau River in Johor Bahru and Kulai districts, Johor State, Malaysia, 3–10 September 2024**



The dark read areas represent high case density, while the light red areas indicate low case density.
(a) Location of the incident site within Peninsular Malaysia.
(b) Location of the incident sites in Johor Bahru and Kuali districts.

processes. Both public and private health facilities were placed on high alert to ensure early detection and prompt reporting of cases, thus establishing a real-time feedback loop to monitor and mitigate emerging health threats.

Exposed individuals were defined as those who were in the vicinity of the Tebrau River or its surrounding areas during 3–10 September 2024 and reported exposure to an unpleasant odour associated with the incident, regardless of whether they developed symptoms. Among those exposed, a case was defined as an individual from Johor Bahru or Kulai who developed respiratory symptoms, for example, coughing, difficulty breathing and sore throat, or nausea or vomiting following exposure to the unpleasant odour during this period.

Medical response

From the onset, health-care facilities, including two government tertiary hospitals in Johor Bahru, were integral to the response, providing critical medical care and preparedness. The District Health Office ensured that health-care providers were briefed on key symptoms associated with chemical exposure, such as respiratory irritation, sore throat and headache. This proactive communication enabled front-line staff to swiftly recognize and respond to cases of suspected exposure. Clinicians in hospitals and primary care clinics prioritized the evaluation of symptomatic cases and maintained vigilance in reporting potential clusters of exposure-related symptoms. Although no significant patterns emerged, the alertness and preparedness of health-care providers enabled the early detection and timely response to any potential threats. When additional pollution sites were identified along the Plentong River and in Kulai, health-care facilities expanded their readiness to accommodate the possibility of wider exposure. The collaborative approach between public health and medical teams ensured a unified response. While the absence of further cases facilitated a gradual return to routine operations, the preparedness measures demonstrated the importance of a cohesive and adaptable medical response in managing environmental health risks.

OUTCOMES

The multifaceted public health and medical response to the Tebrau River chemical pollution incident successfully mitigated its impact on the affected communities. A total of 484 individuals were identified as having been exposed. Their demographic characteristics are summarized in **Table 1**. The majority of those affected were female (61.8%), followed by children aged 0–14 years (43.8%). While most had no prior medical history (50.8%), asthma was the most common comorbidity reported (8.1%).

The symptoms experienced by individuals are detailed in **Table 2**, with dizziness (75.1%), sore throat (58.7%) and coughing (50.0%) being the most frequently reported. Symptom onset was notably acute, with 106 individuals (31.7%) developing symptoms <1 hour after exposure and a total of 249 (74.6%) experiencing symptoms within the first 4 hours. This rapid onset emphasized the importance of early detection and medical intervention.

The rapid public health and medical response ensured timely identification of cases, active engagement with affected communities and swift intervention. Health facilities operated on high alert, enabling the early recognition and management of cases, while collaboration with external agencies supported extended surveillance and monitoring. Despite no significant patterns of severe outcomes emerging, the coordinated efforts helped maintain community trust and limited the health impact of the incident.

Table 1. **Demographic characteristics of individuals exposed to chemical pollution during the Tebrau River incident (*N* = 484), Johor Bahru and Kulai districts, Johor State, Malaysia, 3–10 September 2024**

Variable	*n*	%
Sex		
Male	185	38.2
Female	299	61.8
Age group		
0–14	212	43.8
15–29	77	15.9
30–44	153	31.6
45–59	34	7.0
≥60	8	1.7
Medical history		
Allergy	1	0.2
Asthma	39	8.1
Breast cancer	1	0.2
Diabetes mellitus	12	2.5
Dyslipidaemia	4	0.8
Epilepsy	1	0.2
G6PD	2	0.4
High blood pressure	11	2.3
Ischaemic heart disease	3	0.6
Kawasaki disease	1	0.2
Tetralogy of Fallot	1	0.2
Thyroid disease	3	0.6
Unspecified chronic diseases	2	0.4
No history of illness	246	50.8
Unknown/no records	157	32.4

G6PD: glucose-6-phosphate dehydrogenase deficiency.

DISCUSSION

The Tebrau River chemical pollution incident underscores the complexities of managing environmental health crises in urban river systems. Rapid assessment, collaboration and community engagement were key to mitigating the health impacts. However, the response also exposed several challenges that should inform future preparedness efforts. These include the absence of standard biomarkers to confirm chemical exposure, inconsistent data reporting

Table 2. **Symptoms, time to onset and treatment setting among individuals exposed to chemical pollution during the Tebrau River incident (*N* = 334),[a] Johor Bahru and Kulai districts, Johor State, Malaysia, 3–10 September 2024**

Variable	*n*	%
Symptom		
Chest pain	5	1.5
Cough	167	50.0
Difficulty breathing	108	32.3
Dizziness	251	75.1
Eye irritation	68	20.4
Fever	45	13.5
Headache	24	7.2
Nausea	98	29.3
Runny nose	14	4.2
Skin itching	21	6.3
Sore throat	196	58.7
Vomiting	54	16.2
Others	12	3.6
Time to symptom onset		
<1 hour	106	31.7
1–2 hours	69	20.7
2–4 hours	74	22.2
4–8 hours	31	9.3
8–24 hours	11	3.3
1–2 days	18	5.4
2–3 days	2	0.6
>3 days	1	0.3
No records	22	6.6
Treatment setting		
Hospital admission	5	1.5
Outpatient	329	98.5

[a] The total frequency of symptoms exceeds 334 because an individual may develop more than one symptom.

across public and private health facilities, and limited access to timely environmental data.

Recognizing that biomarker development may be a long-term process, early investment in this area could help strengthen future response capabilities. In the interim, standardized reporting templates, improved communication between public and private health facilities, and joint training across districts can significantly strengthen response coordination. Access to environmental data must also be improved by reducing bureaucratic delays, increasing transparency, and enhancing collaboration between health and environmental agencies.

Despite these constraints, the initial public health response was timely and effective. The swift deployment of assessment teams and proactive community outreach demonstrated that early action is possible, even without complete environmental or toxicological data. This success was supported by lessons learned in previous incidents, such as the incidents affecting the Kim Kim River in 2019 and the Tiram River in 2023. These experiences helped inform preparedness and enabled a more confident, coordinated response. A key takeaway from the Tebrau incident is that public health action should not be delayed by the absence of full environmental data. The emphasis on community engagement also played a vital role in building trust and encouraging collective responsibility. These strengths offer valuable guidance for managing future environmental health emergencies.

Importance of rapid assessment

The Tebrau River incident highlights the critical importance of rapid assessment and collaborative efforts in managing chemical pollution events. Lessons from previous incidents, such as the Kim Kim River crisis in 2019, have enhanced preparedness and response capabilities. The Kim Kim River incident, which led to over 900 students seeking medical care, emphasized the need for a structured response framework.[1] This preparedness enabled the Johor Bahru District Health Office to promptly deploy a RAT to conduct site evaluations and implement active case detection. The chemicals involved in this incident, primarily VOCs, highlighted the urgency of rapid action, as symptoms typically manifest acutely within 1 hour of exposure, requiring immediate medical attention. A major challenge in managing chemical exposure is the lack of standardized biomarkers for assessing exposure levels and health effects.[3] To date, efforts in Malaysia to develop exposure biomarkers have been limited, and current guidelines do not incorporate biomarker use. The absence of established biomarkers complicates the confirmation of exposure, the evaluation of health impacts and clinical management. This underscores the need for timely, well coordinated responses, combined with advancing research and standardization in biomarker development, to improve the management of chemical pollution incidents.

Cross-health facilities coordination is essential

The involvement of multiple health facilities, including hospitals, district health offices and clinics, highlighted gaps in coordination and data standardization during the response. While all facilities followed the same response protocols, differences in reporting formats led to inconsistencies in the variables recorded, complicating comparative analyses and response strategies. In the absence of pre-established templates, data collection tools were developed on an ad hoc basis during the early phase of the incident. Although minor, these differences underscored the need for harmonized reporting systems to ensure seamless data integration. Staff turnover due to administrative reshuffling further disrupted continuity and hindered knowledge transfer during the response. Studies have shown that standardized data collection and cross-district training programmes are essential for effective emergency management in multijurisdictional contexts.[4,5] Moving forward, efforts should prioritize the alignment of reporting formats, consistent training across facilities, and the establishment of robust communication channels to enable seamless collaboration and data sharing during emergencies.

Community engagement enhances preparedness

Although chemical pollution incidents affect entire populations, vulnerable groups, such as children and individuals with pre-existing conditions, are disproportionately impacted. This was evident during the Tebrau River incident, where schools were identified as critical points for intervention. Proactive community engagement efforts, including outreach to schools and education on minimizing exposure risks, played a vital role in protecting these vulnerable groups. Previous studies have highlighted the importance of community engagement in building resilience during public health emergencies.[6,7] Moreover, educating communities about potential health risks and protective measures fosters trust and empowers individuals to act effectively during crises.[8,9] Strengthening relationships between public health authorities and local communities will be crucial in enhancing preparedness for future environmental health emergencies.

The need for integrated environmental data

The Tebrau River incident highlights the critical need for integrated environmental data to enhance response efforts during chemical pollution events. Such incidents typically involve multiple agencies, including environmental authorities, which manage data on contamination sources and the extent of pollution. However, coordination with environmental agencies is often hindered by procedural barriers, siloed data systems and legal constraints – particularly when incidents lead to potential litigation. These complexities can delay the availability of crucial information needed by health authorities to assess risks and implement timely interventions. The establishment of streamlined data-sharing mechanisms and the fostering of stronger inter-agency collaboration are essential in overcoming these challenges. Integrated environmental data systems would enable real-time access to critical information and facilitate more efficient and effective responses to chemical pollution incidents.

Limitations

This investigation had two main limitations. First, symptom data were based on self-reports and may be subject to recall bias or underreporting. Mild or transient symptoms could have gone unnoticed, potentially leading to an underestimation of the true extent of exposure. Second, the specific chemical composition of the pollutants was not confirmed during the response period. The response was guided by the presumption of VOC exposure based on reported symptoms and odour complaints. While this was sufficient for managing acute effects, the lack of confirmed chemical identification limited the ability to fully assess potential long-term health risks.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Ethics statement

Formal ethical approval was not sought as research was not undertaken. Approval and permission to publish were received through the Director-General of Health, Malaysia before the paper was submitted for publication.

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Western Pacific regional engagement in the Emergency Medical Team Global Meeting 2024

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The 6th Emergency Medical Team (EMT) Global Meeting was held in Abu Dhabi, United Arab Emirates on 5–7 November 2024.[1] This was the largest EMT Global Meeting to date, with over 1300 participants from more than 140 countries across all six regions of the World Health Organization (WHO). Discussions focused on health emergency response, coordination, lessons identified, best practices and future advancements in EMTs. The WHO Western Pacific Region was the second most represented region attending the meeting, with over 100 participants from 23 of the 37 countries and areas in the Region. The Western Pacific is home to 16 WHO-classified EMTs, and almost every country or area in the Region has a national and/or international EMT. The meeting provided an opportunity for participants to share, collaborate with and learn from colleagues both regionally and globally.

Participants and representatives from the Region actively contributed to various panels, discussions, working sessions and abstract presentations during the 3-day meeting. The EMT Global Meeting's core theme was the implementation of the EMT 2030 strategy, expanding on the minimum standards set in the *Classification and minimum standards for emergency medical teams*.[2,3] A half-day Western Pacific Regional Meeting was held on the first day to bring together EMT members from the Region to celebrate successes, share lessons identified and plan for future nationally led, regionally supported health emergency responses.

The Western Pacific Region was well represented throughout the EMT Global Meeting (**Table 1**). EMT members from the Region presented in almost every plenary, technical and research-focused session (**Table 2**). Over 200 abstracts were submitted from 58 different countries for presentation. Of the 32 oral abstracts accepted for presentation, 13 were from the Region (**Table 2**), while 22 additional research abstracts were accepted for poster/digital presentation from the Region. Mercy Malaysia, Singapore Ministry of Health EMT and three teams from the Philippine Emergency Medical Assistance Team were recognized as newly classified international EMTs. The Australian Medical Assistance Team, New Zealand Medical Assistance Team and Japan Disaster Relief Team were recognized for their reclassification.

Over 100 governmental and nongovernmental EMT representatives from more than 21 countries and areas attended the meeting's regional session, which included the nomination of a new Regional Chair Group and a "world café" session to engage participants in shaping the future regional response. The Western Pacific Regional Group nominated and selected the new Regional Chair Group: Incoming Chair – Philippines;

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Table 1. **Participation of representatives from countries/territories/areas in the WHO Western Pacific Region at the Emergency Medical Team Global Meeting, Abu Dhabi, United Arab Emirates, 5–7 November 2024**

Country/territory/area	No. of participants
American Samoa (USA)	1
Australia	14
Cambodia	4
China	6
Cook Islands	2
Fiji	3
Japan	12
Kiribati	1
Lao People's Democratic Republic	2
Malaysia	2
Mongolia	3
New Zealand	6
Northern Mariana Islands, Commonwealth of the (USA)	2
Palau	3
Papua New Guinea	3
Philippines	14
Republic of Korea	5
Samoa	4
Singapore	2
Solomon Islands	3
Tonga	2
Vanuatu	2
Viet Nam	1
WHO Western Pacific Regional Office	8
Total	**105**

WHO: World Health Organization.

Outgoing Vice-Chair – Samoa; Incoming Vice-Chair – Papua New Guinea; and Nongovernmental Representative – Pasifika Medical Association.

The world café session focused on eight thematic topics covering national, regional and international deployments, interoperability, EMT logistics, water, sanitation and hygiene (WASH), specialization, training and the impacts of climate change on emergency response. Key takeaways from the regional session emphasized the need to expand collaborative training, including topic-specific training and exercises for EMT logistics, WASH, sustainable practices, EMT coordination and climate change actions. Participants from the Region endorsed the creation of an online platform for EMTs and members to mainstream collaboration and sharing. They emphasized the need to continue strengthening interoperability, national EMTs, national EMT governance, and subregionalization with a common training content, common cache, regular joint exercises and common information management systems.

The EMT Global Meeting served as a valuable platform for teams to share operational experiences and engage in strategic discussions on the future growth of the EMT initiative,[4] which aims to enhance the speed and quality of national and international EMT responses. Dialogue from the meeting will help shape regional priorities for health emergency preparedness and response moving forward. A key benefit of such gatherings is the opportunity for participants to build relationships and trust before collaborating during a health emergency

Table 2. **Topics presented by representatives of countries/territories/areas in the WHO Western Pacific Region at the WHO Emergency Medical Team Global Meeting, Abu Dhabi, 5–7 November 2024**

Country/territory/area	Topic
Australia	1. Keynote speech 2. Expanding partnerships 3. All-hazards, One Health 4. Concrete challenges from EMT operations and particularities of medical civil-military coordination 5. New challenges: modularization and implementation strategies 6. Towards a One EMT information management system – innovative online toolbox for AUSMAT and EMTs: enhancing information sharing and operational transparency 7. Review capacity and standards of local EMTs in the post-pandemic period 8. AUSMAT rehabilitation team member training 9. Evaluation of the AUSMAT mentorship pilot program 10. The characteristics of high-performance teams for infectious disease responses: an AUSMAT team leader's perspective 11. Ready, set, deploy: AUSMAT's surgical cache gets a makeover 12. Evaluating and enhancing team member training: an 8-week program for AUSMAT using modern collaboration techniques and adult learning principles
Fiji	1. All about quality – a local EMT deployment to Fiji 2. New challenges: modularization and implementation strategies 3. FEMAT response to Tropical Cyclone Cody 4. FEMAT response to leptospirosis outbreak in Navosa, Fiji 5. FEMAT – Tuvalu COVID-19 surge support
Japan	1. Enhancing emergency response 2. Towards a One EMT information management system 3. Joint operation among EMT, FETP and PHRRT during Noto earthquake Japan 2024 4. Japan disaster relief medical mission operating system – key achievement and lessons learned 5. Health checkup of EMT members during 2024 Noto peninsula earthquake in Japan 6. Innovative occupational health system for EMT staff implemented by the EMTCC during Noto earthquake 2024 in Japan 7. Assessment of the quality of MDS data collected by EMTs during Idai Cyclone of Mozambique 8. Relationship between fatigue and presenteeism of EMT members in Noto peninsula earthquake in Japan (2024) 9. The role of information management and MDS in disaster response 10. Predicting the number of consultations by EMTs during disasters using a new statistical model 11. Comparative analysis of information management practices by WHO EMTCC during major disasters: Cyclone Idai (2019), the Republic of Moldova refugee crisis (2022), Türkiye earthquake (2023), and Palestine humanitarian crisis (2024) 12. Information management and action plan determination by national EMT, Japan's DMAT: strategic approaches at the prefectural emergency operation centre 13. Strengthen data management capacities of EMTCCs 14. Application of advanced technologies by EMTs and EMTCCs in disaster settings: a scoping review
New Zealand	1. Sustainable strategies and financial models for EMTs 2. New challenges: modularization and implementation strategies 3. Future standards: telehealth for health emergency response – partnering in the Pacific: PACMAT experience 4. Stopping the bleed: can just-in-time training improve the tourniquet application competencies of bystanders and first responders? A randomized control trial
Northern Mariana Islands, Commonwealth of the (USA)	1. Climate change and climate-related emergencies
Palau	1. EMT training and capacity-building
Papua New Guinea	1. EMT-ECO: synergies with emergency care – the PNG EMT: strengthening standardized emergency care while responding

Country/territory/area	Topic
Philippines	1. Climate change and health high-level strategic discussion 2. Enabling EMT 2030 implementation 3. Global Health Emergency Corps 4. Sustainable strategies and financial models for EMTs 5. Nonlinear progression and multivariant consideration towards classification and reclassification 6. Towards a One EMT information management system 7. PEMAT information systems: digitalizing health emergency and disaster response 8. PEMAT: what began as a domestic necessity has evolved into a global asset 9. Enhancing mass casualty preparedness: inter-agency collaboration in an airport emergency response exercise
Republic of Korea	1. Enhancing KDRT's training and capacity building programs: a systematic review 2. Multidimensional analysis of attacks on medical facilities and hospitals: evidence of humanitarian crisis during the Syrian war 3. Enhancing KDRT's administration and organizational management through SWOT analysis: a systematic review 4. Developing guidelines to enhance technological interoperability of communication and information management systems for KDRT medical teams: a systematic literature review
Samoa	1. Highly infectious diseases
Singapore	1. Nonlinear progression and multivariant consideration towards classification and reclassification 2. A unified government–private sector strategy for streamlined Singapore EMT development
Vanuatu	1. EMT deployment in response to Cyclones Judy and Kevin in Vanuatu: coordination, challenges and outcomes
WHO Western Pacific Regional Office	1. New standards: implementation strategies and challenges 2. Implementation tools for medical care in semi- and non-permissive environments 3. EMT warehousing solutions in the Pacific island countries and areas: addressing system and infrastructure challenges to enable emergency deployments 4. WHO guidance on research methods for health emergency and disaster risk management: a tool to build and use evidence to protect health and strengthen EMTs 5. Progress in health data collection and management during and after emergencies and disasters: increasing evidence by EMT minimum data set 6. Designing an EMT cache for extreme cold weather in Mongolia

AUSMAT: Australian Medical Assistance Team; DMAT: Disaster Medical Assistance Team; ECO: emergency, critical and operative care; EMT: emergency medical team; EMTCC: emergency medical team coordination cell; FEMAT: Fiji Emergency Medical Assistance Team; FETP: field epidemiology training programme; KDRT: Korea Disaster Response Team; MDS: minimum data set; PACMAT: Pasifika Medical Association Medical Assistance Team; PEMAT: Philippine Emergency Medical Assistance Team; PHRRT: public health rapid response team; PNG: Papua New Guinea; SWOT: strengths, weaknesses, opportunities and threats; WHO: World Health Organization.

response. The meeting highlighted the successes in the Western Pacific Region and continued progress towards a more mature, integrated approach to emergency medical response.

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Conflicts of interest

JEL and STC are associate editors of the *Western Pacific Surveillance and Response* journal. They were not involved in the editorial decision to publish this article. The other authors have no conflicts of interest to declare.

Ethics statement

Ethical clearance was not required because this report used published and publicly available data. No personal identifying information was collected.

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Detection and characterization of novel respiratory viruses among native ducks (*Anas luzonica*) in Central Luzon, the Philippines

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Objective: This cross-sectional, prospective surveillance study sought to determine the prevalence of novel respiratory viruses among domestic ducks in Central Luzon that are known to have frequent contact with wild avian species. Such contact may lead to novel virus spillover events that may harm domestic poultry as well as humans.

Methods: From March 2019 to January 2020, cross-sectional and prospective surveillance for viruses among domestic ducks (*Anas luzonica*) was conducted by periodically collecting oropharyngeal swabs from ducks on 54 farms across three municipalities within Central Luzon (Region III). A flock of 30 sentinel domestic ducks was also sampled four times after being confined in the Candaba swamp. The resultant 1740 swab samples were pooled (5 samples/pool, 348 pools) by site and screened with molecular assays for respiratory viruses from multiple viral families.

Results: Two farms yielded samples positive for avian influenza virus in Candaba, where adolescent ducks are known to freely mix with wild birds as they graze in rice fields. Overall, the prevalence of avian influenza virus was 2.3% (8/348 pools). Sequencing revealed three pools with highly pathogenic avian influenza H5N6, one with low pathogenicity H5N8, and one with H5 with an unspecified neuraminidase. All the pooled specimens tested were negative for influenza C, adenoviruses, coronaviruses and enteroviruses.

Discussion: Although this study had several limitations, it found supportive evidence that domestic ducks are acquiring avian influenza viruses from wild bird species. These findings underscore recommendations that duck farmers should seek to prevent domestic ducks from mixing with wild avian species.

Respiratory viruses are common among avian species. Wild birds are thought to serve as reservoirs that move novel respiratory viruses across geographical areas and introduce such viruses to livestock species.[1–3] Transmission is accelerated by wild bird migrations, movements of commercial poultry, and close contact between various live bird species in wet markets.[1,2]

Coronaviruses, adenoviruses and enteroviruses are known to cause disease among domestic and wild bird species, often resulting in severe morbidity.[4–6] Of particular public health importance are avian influenza viruses (AIVs), specifically some H5 and H7 subtypes, which occasionally cause illness among humans and other animal species.[7] The highly pathogenic influenza H5N6 virus was first identified in 2013, and infection

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Table 1. **Number of duck farms selected, specimens collected and results of testing for influenza A virus, by municipality, Central Luzon, Philippines, March 2019 and January 2020**

Municipality, province	No. of duck farms in municipality	No. of farms selected	No. of samples collected	No. of pooled samples	No. positive for influenza A virus
Candaba, Pampanga	416	45	1350	270	8
Candaba swamp (sentinel ducks)	N/A	1	120[a]	24	0
San Luis, Pampanga	49	5	150	30	0
Cabiao, Nueva Ecija	36	4	120	24	0
Total	501	55	1740	348	8

N/A: not applicable.

[a] Samples were collected from each of 30 sentinel ducks after their introduction to the Candaba swamp on days 1, 10, 20 and 30.

with this virus includes severe clinical symptoms and mortality across avian species.[8] Forty-seven countries reported AIVs among humans or avian species between December 2022 and June 2023.[9]

In the Philippines, highly pathogenic AIV was first reported in July 2017, when the identification of H5N6 in chickens and quails at egg farms in Central Luzon resulted in the culling of more than 400 000 poultry within 1 km of the outbreak sites.[10,11] At the time, agriculture officials suspected that the source of the outbreak stemmed either from the interaction of domestic birds with migratory waterfowl in the Candaba swamp or the smuggling of live ducks from China.[12] To date, neither hypothesis has been proven.[11] This study sought to identify respiratory viruses of interest among domestic duck populations across Central Luzon that may point towards viral transmission between wild avian species and domestic ducks.

METHODS

Collaboration, recruitment and sample collection

Duck farms were selected from Cabiao municipality in Nueva Ecija province and Candaba and San Luis municipalities in Pampanga province, Central Luzon (**Fig. 1**), by drawing lots from the list of facilities raising ducks in each barangay (i.e. district or ward) and municipality (**Table 1**). Selected farms were incentivized to participate in the study through the provision of water-soluble vitamin supplements for their ducks and offers to provide the results of laboratory tests for free. No ducks were vaccinated against the respiratory viruses investigated in this study.

In each of the 54 selected duck farms, the field team explained the study to farm owners and workers, then collected oropharyngeal swabs from 30 birds on each farm using flexible sterile applicator swabs. Workers were asked to catch and sample representative ducks in every pen, for a total of 30 ducks per farm. Samples were placed in a viral transport medium, labelled, stored in a cooler with ice and transported the same day to Regional Field Office III of the Regional Animal Disease Diagnostic Laboratory (RADDL) at the Department of Agriculture, Pampanga. The study team also collected descriptive data about the farm, the ducks on each farm and duck-grazing habitats.

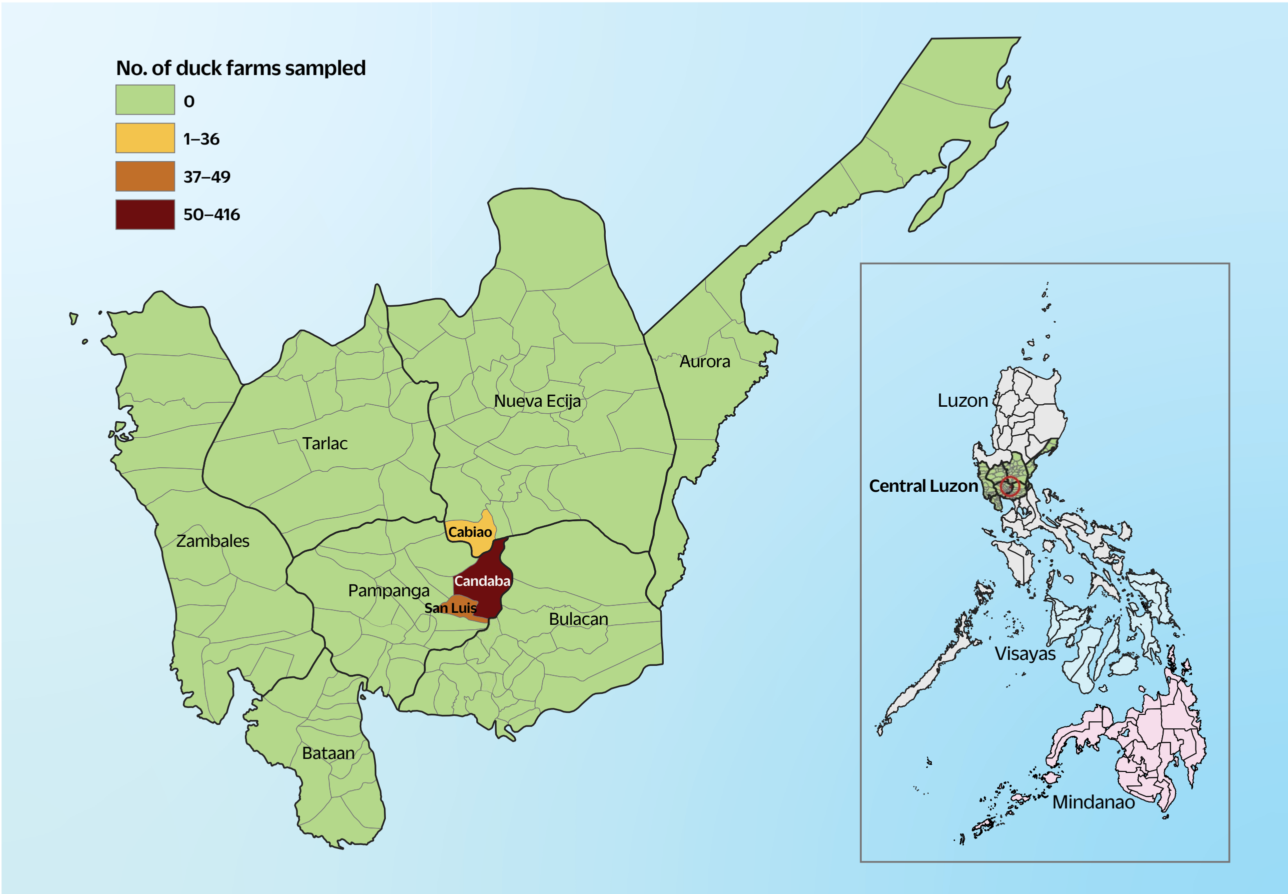
To determine whether the source of the first bird flu outbreak in the Philippines in 2017 was from migratory birds, a flock of 30 sentinel ducks was purchased and placed in the Candaba swamp. They were fenced in with netting and sampled four times, 10 days apart, during the height of the migration season (November to December 2019), using the same methods as described above.

Researchers and farm workers wore appropriate personal protective equipment (PPE) including scrub suits, laboratory gowns, face masks, face shields, gloves and boots during sampling. Disposable PPE and used applicator swabs were autoclaved in the laboratory before disposal. Nondisposable PPE was cleaned and disinfected.

Laboratory testing

Nucleic acid extraction was performed using the QIAamp MinElute Virus Spin Kit (Qiagen, Germantown, MD, USA)

Fig. 1. **Map of Central Luzon/Region III, Philippines, showing the municipalities (Cabiao, Nueva Ecija province; Candaba and San Luis, Pampanga province) where the sampled duck farms were located**



at the Regional Avian Influenza Diagnostic Laboratory (located at RADDL), according to the manufacturer's instructions. Five field samples from the same farm were combined into one pool and vortexed. RNA from each pool was extracted and aliquoted into three tubes for matrix gene detection, haemagglutinin subtyping and characterization, and then stored at -80 °C.

The pooled samples were screened for influenza A and C viruses, adenoviruses (pan-species), coronaviruses (pan-species) and enteroviruses (pan-species) at RADDL in Central Luzon using quantitative reverse transcription–polymerase chain reaction (qRT–PCR) protocols provided by Duke University.[13] Samples positive for influenza A were sent to the Research Institute for Tropical Medicine and the University of the Philippines to determine the haemagglutinin subtype.

RNA extracted from the pooled samples, which tested positive for influenza A virus, was shipped to the CSIRO Australian Centre for Disease Preparedness (ACDP) for confirmation and further characterization. When the results of the molecular assays were discordant between the Philippine and Australian laboratories, the results from the ACDP were reported, as it is a World Organisation for Animal Health reference laboratory for avian influenza.

RESULTS

Samples

A total of 1740 oropharyngeal swabs were collected between March 2019 and January 2020, resulting in 348 pooled samples from 54 domestic duck farms and the sentinel ducks inserted in the Candaba swamp. Of these, 24 pooled samples were from the sentinel ducks (**Table 1**). All ducks appeared healthy when samples were collected.

Table 2. **Results of molecular assay for influenza A virus, by age of duck, Central Luzon, Philippines, March 2019 and January 2020**

Age of duck	No. of farms	No. of farms with positive samples	No. of farms with negative samples
5 months	8	0	8
6 months	34	1	33
8 months	13	1	12
Total	55	2	53

Table 3. **Haemagglutinin typing results for samples with influenza A viruses (*n* = 8), by farm with corresponding grazing area, Central Luzon, Philippines, March 2019 to January 2020**

Laboratory ID of the farm (sample pool no.)	Haemagglutinin subtype	Grazing area	Age of duck (months)
1754 (4)	H5	Rice field	8
1754 (2)	H5	Rice field	8
289 (1)	H5	Rice field	6
289 (2)	H5	Rice field	6
289 (3)	Not determined	Rice field	6
289 (4)	H5	Rice field	6
289 (5)	H5	Rice field	6
289 (6)	H5	Rice field	6

Table 4. **Sequence typing results for influenza A viruses detected at duck farms, Central Luzon, Philippines, March 2019 and January 2020**

Laboratory ID of the farm	Sample pool no.	Test		Sequence results
		Avian influenza virus type A	Avian influenza virus H5	
1754	2	Positive	Positive	Undetected
1754	4	Positive	Positive	Positive for H5N8
289	1	Positive	Positive	Undetected
289	2	Positive	Positive	Positive for H5N6
289	3	Positive	Negative	Undetected
289	4	Positive	Positive	Positive for H5
289	5	Positive	Positive	Positive for H5N6
289	6	Positive	Positive	Positive for H5N6

Influenza A virus

Of the 348 pooled samples, 8 (2.3%) were positive for influenza A virus (**Table 1**). These positive pooled samples were from two farms in two different barangays in Candaba, Pampanga. Infected ducks in these pooled samples were aged 6–8 months, and all had a history of grazing in the rice field (**Tables 2**,**3**).

The 24 pooled samples from the sentinel ducks were all negative for influenza A virus (**Table 1**). Thus, they did not acquire AIV during the 30 days of sampling in the Candaba swamp.

In haemagglutinin characterization, 7 of the 348 (2.0%) pooled samples were positive for avian influenza H5 (**Table 3**). Next-generation sequencing confirmed the presence of clade 2.3.4.4 highly pathogenic H5N6 in several samples (GISAID EpiFlu accession numbers EPI3467823–EPI3467846), with one additional sample having evidence of low pathogenicity avian influenza H5N8 (**Table 4**), GISAID EpiFlu accession numbers

EPI3467819–EPI3467822. The H5 subtype detected was similar to other related viruses previously identified in the Philippines.

Other respiratory pathogens

Only 316 pooled samples were tested for adenovirus with the qRT–PCR assay due to insufficient reagents. None of the pooled samples yielded molecular evidence of influenza C virus, coronaviruses, adenoviruses or enteroviruses.

DISCUSSION

Of the 54 participating farms and the sentinel duck site in Central Luzon, samples from two farms were positive for influenza A virus. Eight (2.3%) of the 348 pools were positive for influenza A. These positive specimens were obtained from ducks aged 6–8 months with a history of grazing in rice fields after harvest season, allowing them to mix with wild birds that were also feeding in the rice fields. Duck farmers often pasture young ducks in rice fields and other bodies of water where migratory birds may reside to lessen the cost of feed and to control golden snails, other pests and insects infesting these bodies of water. When ducks begin to lay eggs, they are confined to laying houses that are often open to wild bird incursions (personal communication with the Provincial Veterinary Office of Pampanga).

Despite detecting AIV in farmed ducks, the molecular studies for the 30 sentinel ducks were all negative for influenza A virus, thus transmission of AIV from wild birds to sentinel ducks in the Candaba swamp could not be demonstrated during their 30-day stay in the area. This could be due to the limited time and space that the sentinel birds had to mix with wild birds due to being confined in netting.

The sequencing results from ACDP identified multiple strains of highly pathogenic avian influenza among the surveyed flocks, including an H5N6 strain similar to a strain associated with the 2017 outbreak. This is of particular concern, as low levels of circulating highly pathogenic AIV may quickly lead to additional large-scale outbreaks, with catastrophic consequences, if not properly identified and curtailed. The 2017 outbreak caused public panic due to fear of humans becoming infected by consuming duck eggs or meat. The additional H5N6 outbreaks in 2020, along with the identification of H5N1 in Pampanga in 2022[14] and again in 2023,[15] attest to the difficulty of eliminating AIVs once they have become enzootic in domestic livestock. While all ducks appeared healthy during sampling, the presence of AIVs in these populations presents the possibility that these ducks could asymptomatically transmit avian influenza A viruses to chickens or quail housed at nearby farms.

The ducks in this study were not vaccinated against AIV or the other respiratory viruses investigated. In late 2023, the Philippine Department of Agriculture issued guidelines on targeted AIV vaccination to pre-empt future outbreaks and complement the existing vaccination programme.[16] However, AIV vaccines are not part of the mandated vaccination schedule for domestic poultry and remain at the discretion of the farmer.

This study had several limitations. We sampled ducks from only 55 sites in Central Luzon and could have missed important circulating AIVs. We used only oropharyngeal sampling to prevent further stress on laying ducks and for ease of collection. Our sentinel duck experiment could have failed due to the short period (30 days) the ducks were exposed to wild birds and also due to their confinement within netting that limited their mixing with wild birds.

Despite these limitations, the findings are consistent with the notion that wild birds are introducing AIVs to farmed ducks. These findings underscore recommendations from the Government of the Philippines that duck farmers should protect domestic ducks from contact with wild birds.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Ethics statement

This study was reviewed and approved by the ethics committee at the Research Institute for Tropical Medicine (approval no. IACUC 2019-11) in Alabang, Muntinlupa City, in collaboration with the Department of Agriculture of the Philippines.

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Enhanced case finding and self-isolation measures in the early phase of SARS-CoV-2 Omicron transmission, Osaka, Japan, December 2021–January 2022

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Objective: The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) variant B.1.1.529 (Omicron) was first detected in Japan in November 2021. In Osaka, public health centres subsequently increased active case finding and encouraged self-isolation. This study investigated the effectiveness of these countermeasures.

Methods: Cases targeted for analysis were persons who had neither recently travelled abroad nor had contact with foreign tourists but tested positive for SARS-CoV-2 between 24 November 2021 and 4 January 2022 and were suspected or confirmed to have the Omicron variant. We performed a descriptive analysis and calculated the reproduction number (R) for each generation using the branching process method. Genomic sequencing data were analysed to plot a haplotype network.

Results: A total of 251 cases were analysed. The median age was 30 years, and 46% (115/251) were in their 20s or younger. The first Omicron case in Osaka was detected on 21 December 2021. Local public health centres conducted health monitoring and contact tracing. We analysed R, using information from six clusters, including 42 pairs with a clear relationship between the case and the infected contact (infector–infectee pairs); the clusters had 19, 21 and 2 cases in each subsequent generation. The basic R (t = 0) was estimated to be 3.2, and subsequent generations (t = 1, 2) of R decreased to 1.1 and 0.1, respectively. The haplotype network showed that these cases constituted a monophyletic group with others detected around Osaka, indicating that these case-related clusters had been contained and were not involved in the nationwide Omicron waves.

Discussion: Active case finding and self-isolation were found to be effective in limiting the spread of an emerging novel variant.

COVID-19, which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), is an infectious disease first reported as unknown pneumonia in China in December 2019; COVID-19 was declared a pandemic by the World Health Organization (WHO) in March 2020.[1,2] In Japan, the first domestic patient with COVID-19 was identified in January 2020.[3] From that point on, contact tracing was conducted, mainly by public health centres (PHCs). By June 2021, PHCs had interviewed every person suspected to have COVID-19, both prospectively and retrospectively, and recommended self-isolation and SARS-CoV-2 tests to their contacts. From July to September 2021, in Japan there was a sudden surge of COVID-19 cases

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Table 1. **Follow up with and definitions of contacts exposed to the Omicron variant of SARS-CoV-2, Osaka, Japan, December 2021–January 2022**

Description and follow up	Category		
	Close contact	Other contact	No direct contact
Definition	Face-to-face contact within 1 m of case and for at least 15 minutes	Frequent contact with case even if physical distance was maintained Living with case in dormitory or another place with shared facilities, such as dining area or bathrooms	Attends the same facility, workplace, or school as the case
Health monitoring	Yes	Yes	Yes
Testing	Yes	Yes	Yes
Self-isolation request	Stay at home or at designated accommodation provided by the local government	Refrain from going outside	Avoid contact with other people

infected with the Delta variant of SARS-CoV-2, which led many local governments to change their policies on epidemiological investigations.[4,5] After that, contact tracing focused mainly on high-risk groups, such as those attending day care facilities for elderly people and inpatients at hospitals.[6]

In November 2021, a novel variant of SARS-CoV-2, B.1.1.529, was reported in South Africa. WHO named this variant Omicron and subsequently classified it as a variant of concern.[7] In Japan, the Omicron variant was first detected in November 2021 in a patient who had travelled overseas. Subsequently, in December 2021, a case who had no history of overseas travel was identified. At that time, the Japanese government had implemented stringent border controls, so only a few foreign nationals and Japanese citizens could travel overseas for business.[8] Because of insufficient information about the transmissibility and severity of the Omicron variant, the Japanese Ministry of Health, Labour and Welfare instructed local governments to expand the target population for contact tracing.[9]

PHCs in Osaka Prefecture, the second most densely populated prefecture in western Japan, in the Kansai Region, began enhanced active case finding and encouraged self-isolation of cases and contacts during the early phase of the Omicron wave. However, elsewhere in Japan (i.e. outside the Kansai Region), measures focused mainly on high-risk groups because they were implemented before the emergence of the Omicron variant. This study aimed to assess the effectiveness of these countermeasures by calculating the reproduction number (*R*) for COVID-19 and performing genomic analysis.

METHODS

Cases targeted for inclusion in the analysis were persons who had neither recently travelled abroad nor had contact with foreign tourists but who had tested positive for SARS-CoV-2 between 24 November 2021 and 4 January 2022 and were L452R mutation–negative by reverse transcription–polymerase chain reaction (RT-PCR) or confirmed to have the Omicron variant by whole-genome sequencing analysis.[10,11] PHCs classified contacts of each case using the following categories: (1) close contact, (2) other contact and (3) no direct contact with cases (**Table 1**). As part of the contact tracing procedure, PHCs requested that close contacts and other contacts take a SARS-CoV-2 test, and those who tested negative were monitored to see if they developed any symptoms. Those who developed symptoms were re-tested.

PHCs in Osaka treated the following persons as contacts requiring self-isolation: (1) a person who had face-to-face contact with a confirmed case within 1 m and for at least 15 minutes; (2) a person who had frequent contact with a confirmed case, even if the proper physical distance was maintained; and (3) a person in a living situation with a confirmed case in which there were communal spaces, such as a dormitory with shared dining areas and bathrooms. Contacts were asked to self-isolate in a local government-designated facility or at home, and their health was monitored until 14 days after their last exposure. In collaboration with local PHCs, we estimated the source of infection and established epidemiological links based on the outbreak investigation data collected by PHCs through 4 January 2022.

The *R* for each generation was calculated using the branching process method.[12] We selected events in which there was a clear relationship between the case and the infected contact (infector–infectee pairs), estimated from the date of onset in pairs. Specifically, we selected pairs with distinct onset dates from among the six clusters for which data were available to collect information about epidemiological links. The case with the earlier onset date was defined as the infector and the case with the later onset date as the infectee. To calculate the *R* for each generation, we collected 42 infector–infectee pairs from the six clusters.

Haplotype network analysis is used to describe ancestral relationships between genomic data sets. We conducted this analysis using genomic sequencing data from the National Institute of Infectious Diseases and from local public health institutes to explore the introduction and spread of the Omicron variant.[13,14]

RESULTS

A total of 251 cases detected through PHC investigations were included in the analysis. The characteristics of these cases are shown in **Table 2**. The median age was 30 years (interquartile range, 17–49 years), and 46% (115/251) were in their 20s or younger. Altogether, 70% (175/251) were symptomatic, and 57% (142/251) had been vaccinated twice. People who did not have direct contact with cases did not test positive for SARS-CoV-2.

The epidemic curve by date of onset is shown in **Fig. 1**. The first case infected with the Omicron variant in Osaka had an onset date of 8 December 2021; the Omicron variant was detected on 18 December; and the positive test was confirmed using whole-genome sequencing on 21 December.

Among the 251 cases, we identified eight clusters based on the epidemiological information collected by the PHCs, and the data from six clusters were included in the branching process calculation of *R*. Two of the eight clusters were excluded from the analysis because there were no further generations. For two clusters, the contact occurred at home; the remainder of the contacts occurred at a dinner party, school, an after-school setting, and a day care facility for elderly people. Immediately after the index case was detected by a PHC, the facility associated with a COVID-19 cluster was temporarily closed. Close contacts included those who lived with the case and those who had had contact without wearing a mask. Close contacts were required to self-isolate for 14 days in their homes or at accommodation designated by the local public health authority. People who worked or stayed with colleagues, classmates or facility staff who had COVID-19 were classified as other contacts. At the time of contact, most people had been wearing masks. The PHCs asked contacts to refrain from going out. Those who had had no direct contact with a case, such as students in different classrooms at a school, were eligible for health monitoring and testing. They were not asked to observe substantial behavioural restrictions, but the PHCs urged them to avoid contact with persons other than classmates and family members. The health condition of all persons in each cluster was monitored and tested until 14 days after their last contact with a case.

Fig. 2 shows the relationship between infector–infectee pairs in each generation. This tree includes information about the six analysed clusters (originating from the six index cases), which included 19 cases in the first generation, 21 cases in the second and 2 cases in the third. Thus, a total of 48 cases detected through PHC investigations were included in this analysis.

Cluster 1 involved household transmission. Using active case finding, PHCs included family members living together and relatives living apart as close contacts. Testing and health monitoring were performed for the colleagues of the index case (no. 1) and all attendees and staff at the nursery school that the first generation cases (nos. 2 and 3) attended. As a result of the epidemiological investigation conducted by the PHCs, it was determined that no further transmission occurred among the contacts of the cases, including within the family, and at the school and the kindergarten.

Clusters 2 and 3 originated, respectively, from school and after-school settings. Although the two schools are located in the same city, we could not identify any relationship between the two outbreaks. Each pair had contact in the classroom, in the after-school setting or at home.

Table 2. **Demographic characteristics of cases[a] infected with the Omicron variant of SARS-CoV-2, Osaka, Japan, December 2021–January 2022 (N = 251)**

Characteristic	No.	%
Sex		
Male	119	47
Female	115	46
Unknown	17	7
Age group (years)		
<10	23	9
10–19	47	19
20–29	45	18
30–39	32	13
40–49	30	12
50–59	24	10
60–69	10	4
70–79	23	9
Unknown	17	7
Clinical manifestations[b]		
Symptomatic	175	70
Asymptomatic	29	12
Unknown	47	19
Deaths[b]	0	0
Vaccination history[c]		
Two vaccinations	142	57
One vaccination	5	2
Unvaccinated	29	12
Not eligible for vaccination[d]	22	9
Unknown	53	21
Testing for variant		
Whole-genome sequencing	114	45
Only L452R–negative	137	55

[a] Case definition; persons who had neither recently travelled abroad nor had contact with foreign tourists but who had tested positive for SARS-CoV-2 between 24 November 2021 and 4 January 2022 and were L452R mutation–negative by reverse transcription–polymerase chain reaction (RT-PCR) or confirmed to have the Omicron variant by whole-genome sequencing analysis.

[b] At the time of diagnosis.

[c] Booster doses started in Japan on 1 December 2021.

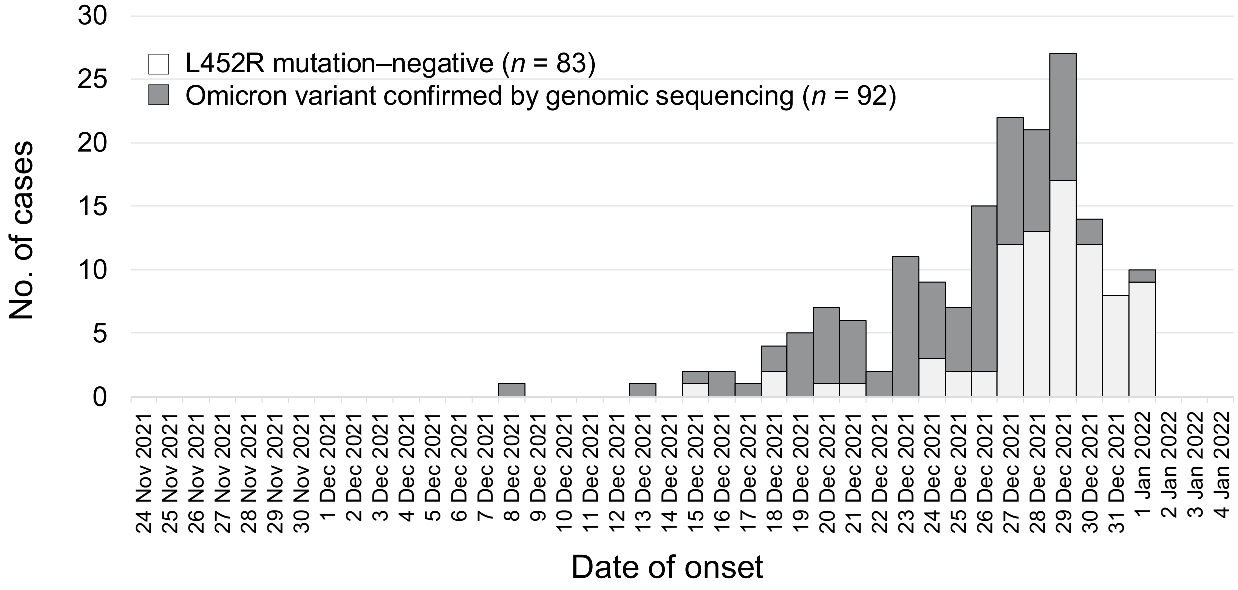
[d] As of 4 January 2022, children younger than 12 years had not been approved for the COVID-19 vaccine.

Cluster 4 involved household transmission. The PHC investigated the work contacts of case 23, but no additional cases were identified.

In cluster 5, cases 25 and 26 were acquaintances who frequently met and had meals together. All second generation cases (nos. 27–33) were suspected to have become infected when they had meals with case 26.

Cluster 6 involved transmission at a day care facility for elderly people. The first case (no. 34) was a staff member. After the case was identified, people who attended the facility and other staff were also diagnosed with SARS-CoV-2 (nos. 35–41). While providing rehabilitation services at the facility, staff wore masks and kept a distance of at least 1.5 m from each other; attendees also followed these precautions. However, the

Fig. 1. **Epidemic curve of COVID-19 in Osaka, Japan, 24 November 2021 to 4 January 2022 (*n* = 175)[a]**



[a] The following cases are excluded from this figure: 29 cases that were asymptomatic at the time of notification to the public health centres and 47 cases with unknown symptoms.

windows were not open to provide ventilation due to safety concerns. The facility was temporarily closed for 14 days. Three cases (nos. 42–44) involved transmissions from attendees to household members. Case 47 also involved household transmission; case 45 was suspected to have been infected by case 40 at another rehabilitation facility. Cases 40 and 46 were acquaintances. Case 48 was a relative of case 45, who lived separately but had contact with case 45; case 45 infected case 48.

In the second generation, the calculated *R* for cases reached 1.1, and in the third generation, it dropped to 0.1. Contacts in the first and second generations were identified by PHCs and were placed under health monitoring. All the primary cases in each pair developed symptoms that led to suspicion of SARS-CoV-2 infection.

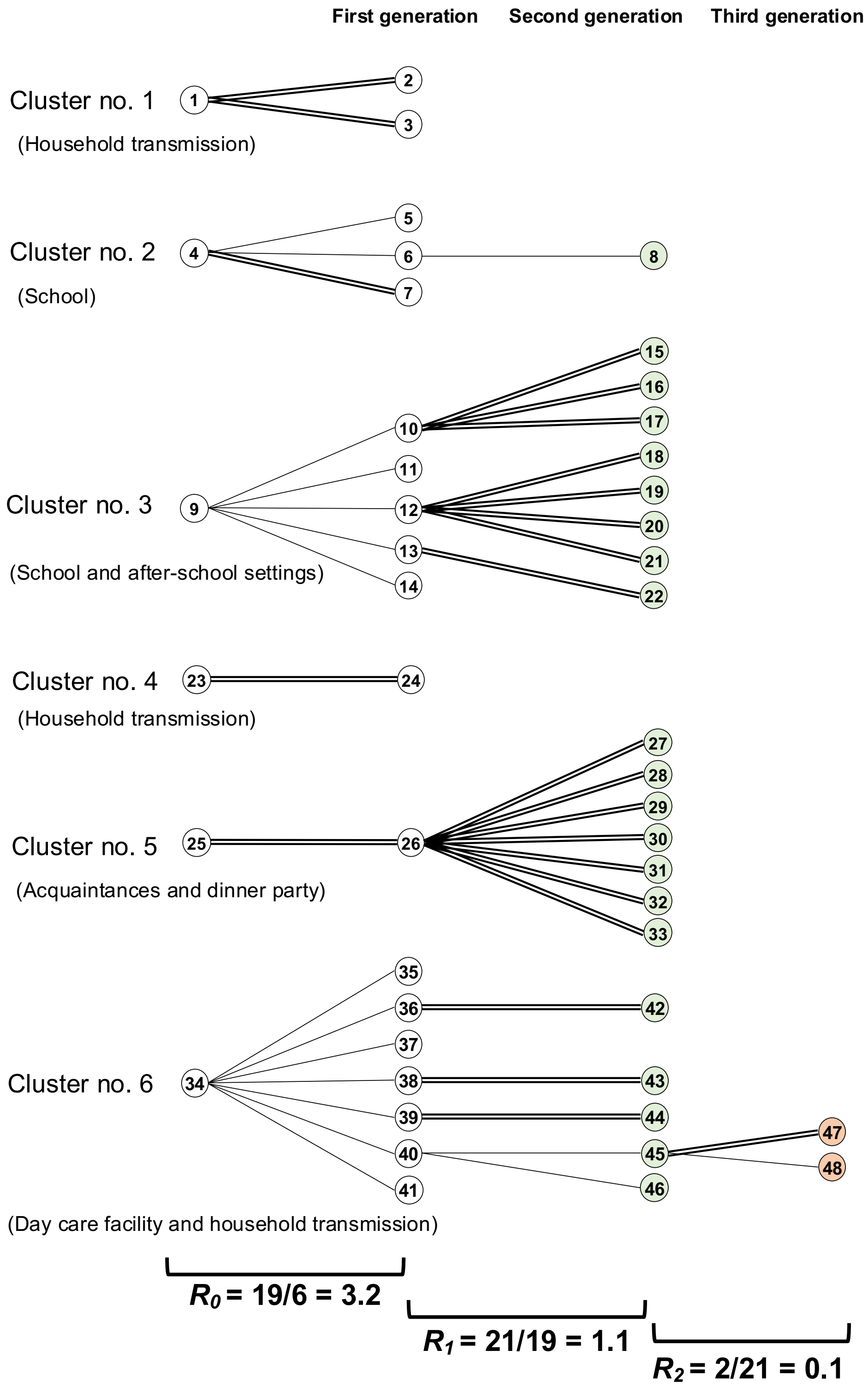
Fig. 3 describes the haplotype networks in which the distribution in each node comprises the cases and shows the identical genome sequence of SARS-CoV-2 between 14 January and 18 February 2022 in Japan. The haplotype network revealed that these cases constituted a monophyletic group, with others detected in Osaka and the surrounding area (i.e. the Kansai Region). The type circulating in the Kansai Region is designated as node a, and its range did not expand much between January (**Fig. 3a**) and February (**Fig. 3b**) of 2022. However, as also shown in **Fig. 3**, node b expanded from the Kyushu, South Region and the Chugoku, Shikoku Region to other regions. This means that other types detected in other regions, including in Okinawa Prefecture (in the Kyushu, South Region) and the Chugoku, Shikoku Region, expanded nationwide.

DISCUSSION

We described the epidemiology of the early phase of the Omicron wave in Osaka Prefecture, Japan, during which PHCs in Osaka increased active case finding and expanded the target population for self-isolation. To evaluate these measures, we calculated the *R* for each generation and found that it had decreased by the second generation. COVID-19 was most often spread in infector–infectee pairs through household transmission. Cases reproduced largely in clusters where people ate and drank together.[15] Our data showed the only clusters associated with a day care facility for elderly people reproduced to a third generation. In addition, according to the haplotype network, the Omicron variant detected in the Kansai Region, which includes Osaka Prefecture, showed limited expansion.

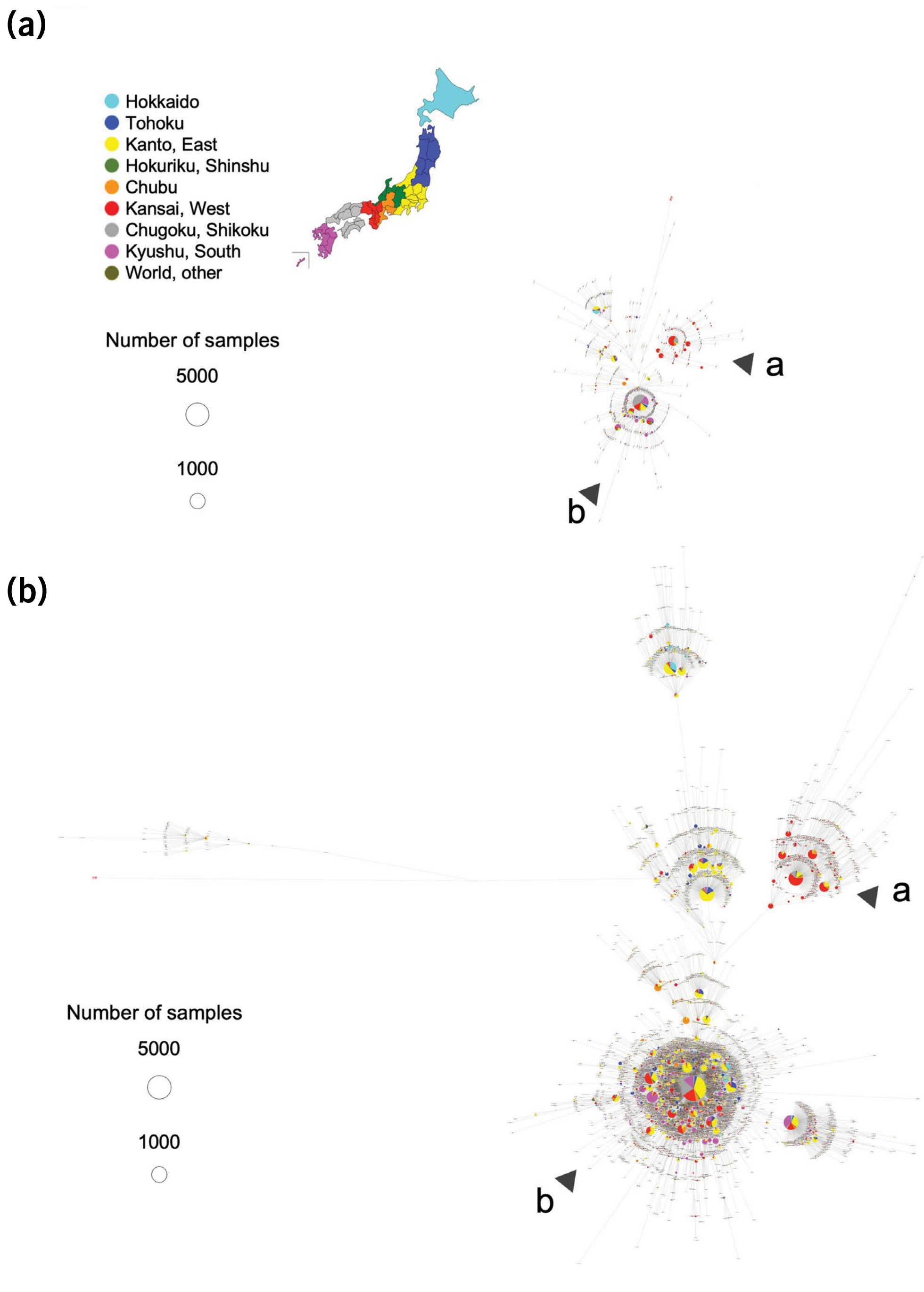
Several studies reported that contact tracing and self-isolation in countries and areas had delayed community transmission during the early phase of the COVID-19

Fig. 2. **Linkage between COVID-19 cases and infected contacts (infector–infectee pairs) and reproduction number (*R*), Osaka, Japan, 24 November 2021 to 4 January 2022**[a]



[a] Each node represents the relationship between an infector and infectee. The numerical values at the bottom of the figure show the number of reproductions in each generation. The double lines indicate close contact (i.e. a pair that had face-to-face contact within 1 m and for at least 15 minutes). A single line indicates a different type of contact (i.e. a pair that had contact frequently, such as at school, even if physical distance was maintained).

Fig. 3. **Haplotype network of the Omicron variant detected in Japan (a) as of 14 January 2022 and (b) as of 18 February 2022**[a]



[a] Both panels have the same scale. The size of the circles indicates the number of strains. The colour of the circle indicates the region where the Omicron variant was detected. Node a represents a sublineage detected mainly in the Kansai Region. Node b represents a sublineage that had spread nationwide.

pandemic.[16–19] For example, in the United Kingdom of Great Britain and Northern Ireland, from January to March 2020, when case numbers were low, contact tracing likely had a significant impact on the course of the epidemic.[16] However, as transmissibility increased, the periods between case detection, contact tracing and self-isolation of contacts became shorter than they had been when the Delta variant emerged and became dominant. For the Omicron variant, isolation after symptom onset was less effective at preventing transmission because of the shortened generation interval.[20] Therefore, many countries reached the limit of contact tracing as the number of cases increased. In Japan, from the middle of the Delta wave, contact tracing focused on those at risk of severe disease in periods and regions where the number of COVID-19 cases was particularly high. Based on uncertainty about the emerging Omicron variant, PHCs in Osaka changed the targets for epidemiological investigation in accordance with the national policy at that time. Every PHC in Osaka enhanced control measures and not only requested that contacts self-isolate but also tested a more comprehensive target population of close contacts. As mentioned above, while PHCs considered the details of the outbreak investigation, they also tested those who did not have direct contact with cases. In addition, local governments provided designated accommodation to ensure that infected cases and close contacts complied with self-isolation, and PHCs confirmed the health condition of close contacts via phone. Furthermore, each PHC urged cases to avoid contact with others to prevent the spread of infection. In fact, no one who did not have direct contact with a case tested positive for SARS-CoV-2 in Osaka. Our data suggest that these enhanced measures contributed to mitigating the spread of the emerging Omicron variant in the Kansai Region.

Just after the Omicron variant was first detected in Japan, airport quarantine procedures were strengthened nationwide, and isolation and health monitoring were required for passengers who had been on a flight with a person infected with the Omicron variant. However, local governments responded in different ways to community-acquired cases of infection with the Omicron variant. First, contact tracing had targeted high-risk groups since the Delta wave, and in some areas, contact tracing continued beyond November 2022. The PHCs, hospitals and clinics in Osaka were able to immediately allocate sufficient personnel to perform contact tracing, health monitoring, testing and genomic surveillance because human resources had been adequately maintained. Second, the Omicron variant spread quickly in Okinawa Prefecture and the Chugoku Region from imported cases.[21,22] Some infected individuals did not respond to requests to participate in epidemiological investigations in these areas for personal or cultural reasons, regardless of whether they could communicate in Japanese. Meanwhile, fewer Omicron variant cases spread to Osaka compared with Okinawa Prefecture and the Chugoku Region.[21,22] When PHCs in Osaka asked persons who did not meet the definition of a close contact to refrain from going out as much as possible, they were generally cooperative, even though self-isolation was not obligatory. The differences in response may have affected the speed of transmission in each region. The weekly number of new COVID-19 cases per 100 000 population as of 5 January 2022 was higher in Okinawa Prefecture (80.07) and the Chugoku Region (10.46) than in the Kansai Region (6.43), which includes Osaka Prefecture.[23] However, by 1 February 2022, the number of new COVID-19 cases in the Kansai Region had increased to 619.15/100 000 population, which was higher than in both Okinawa Prefecture and the Chugoku Region.[24] Moreover, as shown in **Fig. 3**, node b of the haplotype network expanded not only in Okinawa Prefecture and the Chugoku Region but also in the Kansai and Kanto Regions. Node a expanded less than node b; thus, node b showed the expansion of the Omicron variant overall, while node a showed a small expansion nationwide. Our data suggest that the early phase of control measures successfully mitigated the spread of the Omicron variant in Osaka.

Our investigation has several limitations. First, the data are based on information available as of 4 January 2022, which might have underestimated the number of cases due to the time lag between diagnosis and reporting. Second, all primary cases in the study were identified in medical facilities or PHCs. We believe that the PHCs diligently performed contact tracing to identify potential contacts; however, persons with mild cases of COVID-19 might not visit a physician, which would lead to some cases being missed, particularly in the primary generation of branches. Therefore, the value of *R* might have been underestimated based on the available data. Third, some of the cases identified as negative by the L452R screening might have been misclassified as Omicron, given that genomic testing was not available for all cases. Fourth, we might not have obtained sufficiently accurate information about the epidemiological links due to recall bias or social desirability bias.

In conclusion, enhanced active case finding and self-isolation for both cases and contacts may have mitigated community transmission in Osaka during the early phase of spread of the emerging Omicron variant. An emerging novel variant has the potential to spread and cause a pandemic. In reality, several sublineages of SARS-CoV-2 detected outside of Osaka were responsible for the nationwide Omicron wave. During the early phase, there was no information about the characteristics of the emerging novel variant, including its transmissibility and severity. PHCs need sufficient time to consider what kind of response is necessary. The enhanced interventions by PHCs in Osaka were effective in delaying the spread during the early phase of infections with a novel variant of COVID-19, suggesting actions that should be considered in the event of a future outbreak of a novel infectious disease.

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Conflicts of interest

The authors have no conflicts of interest to declare.

Ethics statement

This report was exempt from the requirement for institutional ethics review as the entire activity was conducted as part of public health control measures under the Act on the Prevention of Infectious Diseases and Medical Care for Patients with Infectious Diseases in Japan (Act No. 114 of 1998), and so informed consent was not obtained from the study population.

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Exercise Crystal: simulations that drive National IHR Focal Point capacity-strengthening

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The International Health Regulations (2005; IHR) require States Parties to designate a National IHR Focal Point (NFP; i.e. a national centre) to ensure timely communications with the World Health Organization (WHO) about all events that may constitute a public health emergency of international concern and, following recent amendments, to designate a National IHR Authority to coordinate IHR (2005) implementation within the Parties. Since 2008, the WHO Regional Office for the Western Pacific has been running an annual simulation exercise, known as the IHR Exercise Crystal, to test and strengthen NFP functionality. This study analyses NFP performance during the IHR Exercise Crystal over a 16-year period (2008–2024, excluding 2009) to inform Member States' planning for NFP capacity-strengthening in the context of the recent IHR (2005) amendments. Data collected about NFP performance during these exercises were analysed using descriptive statistics across six key NFP performance indicators. Key findings show that the proportion of NFPs that are accessible via email is consistently high (mean: 99%), but there is suboptimal NFP accessibility via telephone (mean: 64%). The proportion of NFPs participating in tele- and videoconferencing during the exercise improved over time (mean: 73%), as did the proportions of NFPs notifying WHO of simulated events (mean: 80%) and contributing information to the Event Information Site for NFPs (mean: 77%). The proportion engaging in multisectoral communication remained variable, with no clear trend (mean: 73%). These results demonstrate that significant progress has been made in strengthening NFP functionality, but there are opportunities for further improvement, particularly in the areas of telephone accessibility and multisectoral coordination. It is critical that States Parties continue strengthening and testing NFP functionality through simulation exercises and other capacity-building activities to ensure effective IHR (2005) implementation. Furthermore, States Parties should develop, test and maintain up-to-date standard operating procedures to support the clear demarcation of roles and responsibilities between the NFP and the National IHR Authority.

The International Health Regulations (2005; IHR) define countries' rights and obligations in handling public health events and emergencies that have the potential to cross borders.[1] Signatory States Parties commit to developing core capacities for public health emergencies and, under Article 4, are required to designate or establish a National IHR Focal Point (NFP; i.e. a national centre) to communicate with the World Health Organization (WHO). The NFP must be accessible at all times to communicate with WHO IHR Contact Points and is responsible for sending information to WHO on behalf of States Parties, as well as disseminating information to, and consolidating input from, relevant sectors of the Party's administration.[1,2] In the case of territories and areas, States Parties may establish IHR Contact Points specific to each territory or area for the purpose of IHR (2005) communications, although this is not mandatory under the IHR (2005).

IHR (2005) communications and the role of the NFP are central to the Regulations and to global health security. In the recent amendments to the Regulations, which were approved by Member States in June 2024, the requirement to designate or establish an NFP has remained unchanged.[3] However, States Parties must now designate or establish a National IHR Authority, which may be the same entity as an NFP, or a different entity, to coordinate implementation of the Regulations within the State Party.[3] Therefore, in some countries the designation of a National IHR Authority may have an impact on current NFP practices or operations.

In the WHO Western Pacific Region, IHR (2005) implementation is supported through the Asia Pacific Health Security Action Framework (APHSAF).[4] Progress in implementing the IHR (2005), including the NFP and other core capacities, is assessed and monitored through

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the mandatory States Parties Self-Assessment Annual Report (SPAR) and voluntary assessments, including Joint External Evaluations, simulation exercises, and intra- and after-action reviews.[1,5] These assessments help to identify strengths and areas for improvement and then translate them into priority actions as part of national planning to build a country's capacities.[6]

In the Western Pacific Region, the functioning of NFP capacities is routinely assessed through an annual simulation exercise organized by the WHO Regional Office for the Western Pacific. IHR Exercise Crystal has been running since 2008 and aims to test IHR (2005) communication channels and familiarize NFPs and WHO staff with the IHR communication system.[7] Findings from the exercise can inform actions needed to strengthen NFP functionality and should be triangulated with other assessments to better understand the capacity level of countries and to implement priority actions at the national and subnational levels.[5]

This analysis describes the performance of IHR NFPs and Contact Points in the Western Pacific Region during IHR Exercise Crystal over time, with the aim of informing Member States' planning as they prepare for implementing the IHR (2005) amendments.

METHODS

Study design

We conducted a descriptive analysis of IHR NFP and Contact Point performance during IHR Exercise Crystal over a 16-year period (2008–2024, excluding 2009).

Study population and setting

The Regional Office works with health authorities from 37 countries and areas, of which 22 are Pacific island countries and areas, totalling more than one quarter of the world's population.[8] The Region is very diverse; significant variations exist in Member States' geography, demographics, health systems and services, disease burden and disaster risk profiles.[9–11] There are, however, many common challenges and approaches that countries and areas in the Region share, including a common approach to IHR (2005) implementation and capacity development through APHSAF.[4]

Data sources and analysis

Data about NFP performance during IHR Exercise Crystal were extracted from reports and monitoring data sets for the years 2008–2024. Monitoring and evaluation data have been collected each year of IHR Exercise Crystal to measure IHR NFP and Contact Point performance against the exercise's objectives (**Table 1**); however, when monitoring data sets were not available – for 2008, 2010, 2019 and 2021 – only exercise reports were used.

The study used descriptive statistics to summarize and describe the performance of IHR NFPs and Contact Points in the Western Pacific Region during the exercise for six key variables relating to NFP functions (**Table 2**). For each variable, the number and percentage of countries meeting the criteria were calculated for each year, and the mean was calculated for all years. These variables assess whether the IHR NFP or Contact Point is available by email or telephone, or through teleconferencing or videoconferencing; whether they notified WHO about the public health event during the exercise; whether they prepared information to share via the Event Information Site (EIS) for NFPs; and whether they engaged with other stakeholders during the exercise.

RESULTS

Between 2008 and 2024, IHR Exercise Crystal was held 16 times. No exercise was held in 2009; however, during 2009, NFPs communicated frequently with the WHO IHR Contact Point on pandemic influenza A(H1N1), which was a public health emergency of international concern. Additionally, in 2014, an exercise was held with the International Food Safety Authorities Network (INFOSAN), jointly governed by the Food and Agriculture Organization of the United Nations and WHO, which was limited to the then-11 INFOSAN member countries. In 2019, at least five countries were unable to participate in the exercise due to measles outbreaks, leading to a lower participation rate that year. Eleven of the 16 exercise scenarios were related to outbreaks of respiratory viruses (**Table 3**). From 2008 to 2015 (excluding 2014, only States Parties (n = 27) to the IHR (2005) in the Region were invited to participate, with an average of 22 participating countries and areas (range: 18–26) taking part each year. From 2016 onwards, all 37 countries and areas in the Region were invited to

Table 1. **IHR Exercise Crystal objectives, by year, 2008–2024**

Objective	Year																
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Validate the accessibility of NFPs using their registered contact details	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Practise and test the IHR (2005) notification process	NA		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Assess multisectoral communication between NFPs and national counterparts	NA		NA	NA	NA	NA	X[a]	NA	X[b]	X[c]	X	X	X	X	X	X	X
Improve NFPs' understanding of the IHR (2005) communication system	NA		NA	NA	NA	NA	NA	X	X	X	X	X	X	X	X	X	X
Test whether NFPs use tele- or videoconfer-encing	NA		X[d]	X	X	NA	NA	X[e]	X[d]	X	X	X	X	X	X	X	X
Additional objec-tives	[f, g]		[f]	NA	NA	[h]	NA	[i]	[j, k]	[i]	NA	NA	[l]	[l]	[l]	NA	NA

IHR: International Health Regulations (2005); NA: not applicable; NFP: National Focal Point.

[a] The objective was to facilitate communication and collaboration between NFPs and emergency contacts for the International Food Safety Authorities Network (INFOSAN), a joint initiative of the Food and Agriculture Organization of the United Nations and WHO, during a foodborne illness emergency.

[b] The objective was to examine protocols for NFPs working with non-health actors, particularly national disaster management agencies.

[c] The objective was to improve collaboration with other agencies.

[d] This was not listed as an objective but was still tested.

[e] Videoconferencing was introduced to IHR Exercise Crystal in 2015.

[f] An additional objective aimed to test the WHO guide on the IHR (2005) Communications and Duty Officer system (internal document).

[g] The objective was to validate the IHR (2005) verification process between Member States and WHO in response to a public health emergency of international concern.

[h] This focused on improving the engagement of WHO country offices to facilitate communication between NFPs and WHO IHR Contact Points.

[i] The aim was for NFPs to practise the use of IHR (2005) principles and obligations, and to evaluate NFPs' understanding of these.

[j] The objective was to familiarize participants with the IHR (2005) Emergency Committees.

[k] This aimed to test NFPs' ability to log on and use the Event Information Site platform.

[l] A structured scenario was used to explore key issues to identify strengths and areas needing improvement.

Source: Adapted from Table 2 in Li and Li.[12]

participate, with an average of 28 (range: 14–35) taking part each year (**Fig. 1**). Mean participation for the period 2008–2024 (including 2014) was 78% (**Table 3**).

The proportion of participating countries and areas that were accessible via email was consistently high, with a mean of 99% for the period 2008–2024 (**Table 3**). However, the proportion of participating countries and areas that were accessible via telephone has been suboptimal, with a mean of 64% for the period of 2008–2024 (**Table 3**). The proportion of participating countries and areas that joined a teleconference or a videoconference (first introduced in 2015) with the Regional Office during the exercise improved over time, with 85% or more successfully attending between 2021 and 2024, for a mean of 73% over the entire period 2008–2024 (**Table 3**).

The proportion of participating countries and areas notifying the simulated event to the WHO IHR Contact Point has improved over time, with some variation between years. Between 2008 and 2024, a mean of 80% of participating countries and areas notified the simulated event to WHO (**Fig. 2**). The proportion of participating countries and areas that contributed information to an

Table 2. **IHR Exercise Crystal definitions of variables**

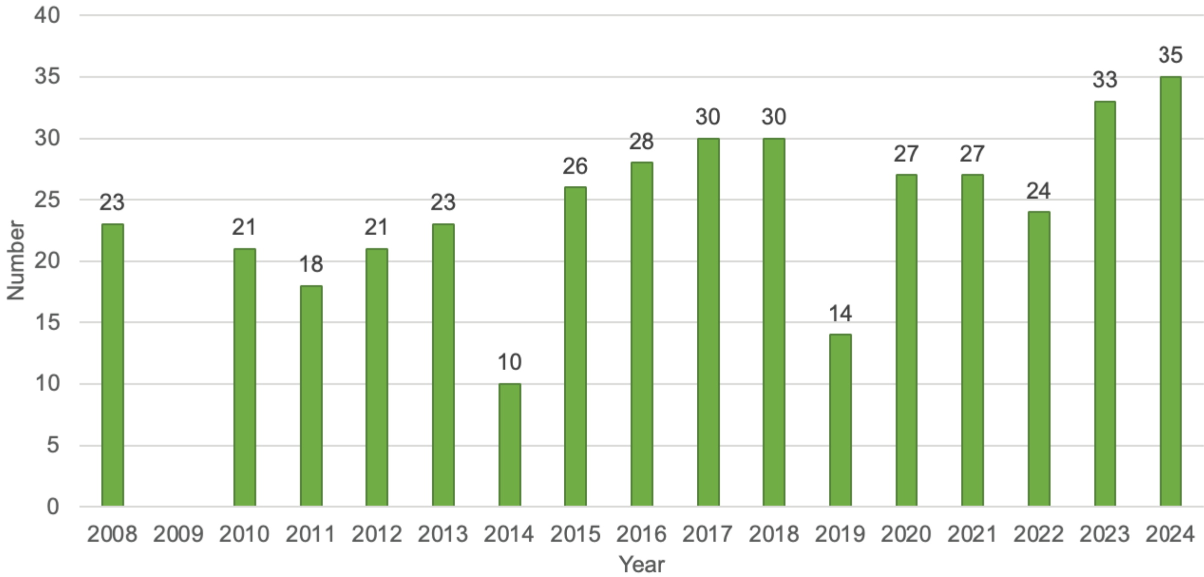
Variable	Definition
Email	The IHR NFP or Contact Point could be successfully contacted by email during the exercise, either through registered contact details or alternative details that had been provided.
Telephone	The IHR NFP or Contact Point could be successfully contacted by telephone during the exercise, either through registered contact details or alternative details that had been provided.
Tele- or videoconference	The IHR NFP or Contact Point could successfully join a tele- or videoconference call, held at the beginning or conclusion of the exercise.
Notification	The IHR NFP or Contact Point emailed the WHO IHR Contact Point to notify the public health event during the exercise.
EIS posting[a]	The IHR NFP or Contact Point emailed the WHO IHR Contact Point to share information about the public health event during the exercise for inclusion in an EIS posting.
Multisectoral communication	During the exercise, the IHR NFP or Contact Point contacted either the exercise Simulator[b] instead of another agency or sector within their country, or a specifically nominated agency, during the exercise.

EIS: Event Information Site; IHR: International Health Regulations (2005); NFP: National Focal Point; WHO: World Health Organization.

[a] An EIS posting is a summary of a public health event and an assessment of its risk that is published to the EIS platform by WHO and accessible to all States Parties. Each EIS posting contains the following elements: core event details, WHO IHR Contact Point details, IHR (2005) Annex 2 criteria, situation summary, public health response, a WHO risk assessment and WHO's recommendations. The EIS process involves WHO assessing whether information about public health events should be posted to the EIS platform, based on certain criteria, and if the criteria are met, initiating an EIS posting in consultation with Member States. However, in practice, some Member States also initiate EIS postings in consultation with WHO, and these are subject to the same WHO criteria and assessment.

[b] The Simulator is a role created for the purposes of IHR Exercise Crystal and is played by designated staff in the WHO Regional Office for the Western Pacific during the exercise. Participating countries and areas may contact the Simulator instead of a real government department, other agency or expert that they would like to interact with as part of the exercise scenario. The Simulator only responds to emails from participating countries and areas; contact is not initiated by the Simulator.

Fig. 1. **Number of countries and areas participating in IHR Exercise Crystal, by year, 2008–2024[a]**



IHR: International Health Regulations (2005).

[a] No exercise was held in 2009. In 2014, only members of the International Food Safety Authorities Network (INFOSAN) (n = 11), a joint initiative of the Food and Agriculture Organization of the United Nations and the World Health Organization, were invited to participate in the exercise (i.e. no Pacific island countries or areas took part). In 2019, only one Pacific island took part in the exercise. At least five countries abstained due to ongoing measles outbreaks at the time of the exercise.

EIS posting has typically followed a similar trend to that of notifications, with some variation in 2023 and 2024. Between 2008 and 2024, a mean of 77% of participating countries and areas contributed information to an EIS posting (**Fig. 2**).

Data for the variable about multisectoral communication were limited for the period 2008–2024, as this was not an objective of IHR Exercise Crystal for 6 of the 16 years (**Table 1**). Although no clear trend in the capacity of NFPs to conduct multisectoral communication

Table 3. **Summary of the performance of participating countries and areas during IHR Exercise Crystal, by year, 2008–2024**

Year	Scenario	No. (%) of participants[a]	Variable[b]					
			Email	Telephone	Tele- or video-conferencing	IHR (2005) notification[c]	EIS posting[c]	Multisectoral communication
2008	Disease X outbreak	23 (85)	19 (83)	13 (57)	–[d]	–	–	–
2009								
2010	Disease X outbreak	21 (78)	21 (100)	12 (57)	15 (71)	–	–	–
2011	Severe acute respiratory illness outbreak	18 (67)	17 (94)	9 (50)	16 (89)	5 (28)	9 (50)	–
2012	Influenza-like illness outbreak	21 (78)	21 (100)	18 (86)	17 (81)	15 (71)	12 (57)	–
2013	Severe acute respiratory illness outbreak	23 (85)	23 (100)	15 (65)	–	18 (78)	17 (74)	–
2014	Verocytotoxin-producing *Escherichia coli* outbreak	10 (91)	10 (100)	6 (60)	–	10 (100)	10 (100)	10 (100)
2015	Novel influenza outbreak	26 (96)	26 (100)	21 (81)	10 (38)	21 (81)	20 (77)	–
2016	Novel coronavirus outbreak	28 (76)	28 (100)	8 (29)	8 (29)	22 (79)	21 (75)	18 (64)
2017	Novel influenza outbreak in cats, with human infections	30 (81)	30 (100)	26 (87)	18 (60)	26 (87)	24 (80)	24 (80)
2018	Novel *Francisella tularensis* outbreak (deliberate use of a biological agent)	30 (81)	30 (100)	25 (83)	20 (67)	26 (87)	24 (80)	16 (53)
2019	Novel influenza outbreak	14 (38)	14 (100)	–	–	14 (100)	14 (100)	–
2020	Potential adverse effects following immunization with a vaccine for a novel respiratory virus	27 (73)	27 (100)	20 (74)	17 (63)	25 (93)	21 (78)	20 (74)
2021	Novel influenza outbreak	27 (73)	27 (100)	17 (63)	23 (85)	21 (78)	19 (70)	22 (81)
2022	Novel influenza outbreak	24 (65)	24 (100)	12 (50)	23 (96)	23 (96)	24 (100)	21 (88)
2023	Radiological event	33 (89)	33 (100)	20 (61)	31 (94)	30 (91)	14 (42)	17 (52)
2024	Emerging arbovirus outbreak (Oropouche virus)	35 (95)	35 (100)	21 (60)	35 (100)	20 (57)	31 (89)	23 (66)

EIS: Event Information Site; IHR: International Health Regulations (2005).

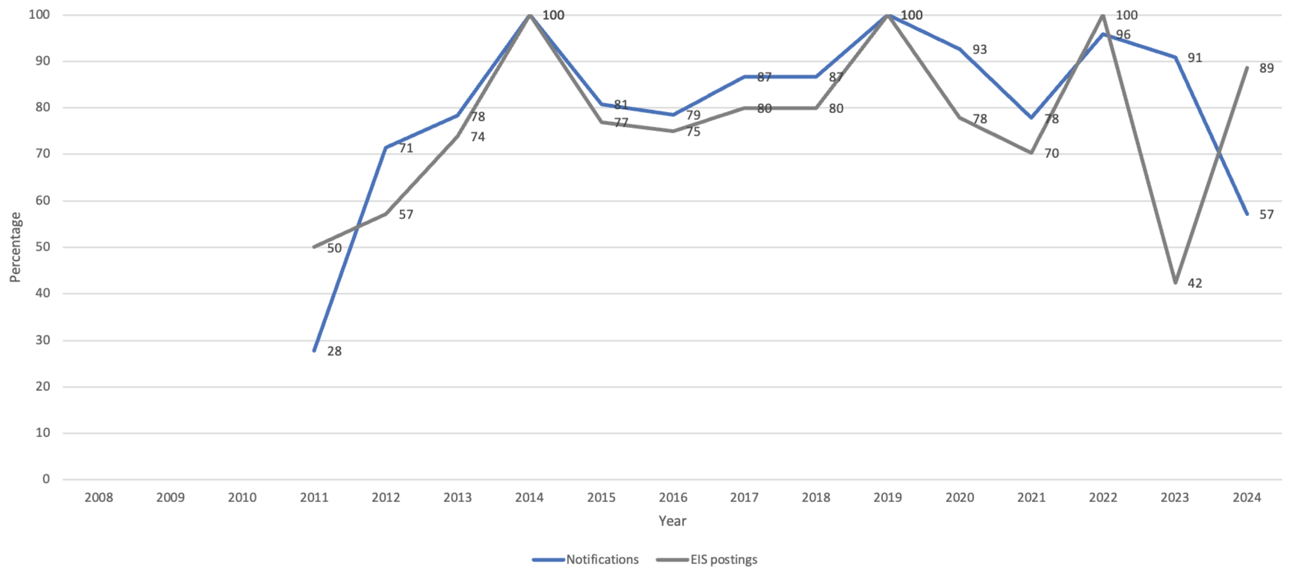
[a] Between 2008 and 2015, all States Parties (n = 27) were invited to participate, with the exception of 2014 when only countries who were members of the International Food Safety Authorities Network (INFOSAN) (n = 11), a joint initiative of the Food and Agriculture Organization of the United Nations and WHO, were invited. From 2016, all countries and areas in the Western Pacific Region were invited to participate (n = 37). No exercise was held in 2009.

[b] Values are n (%).

[c] Data for IHR (2005) notification and EIS posting completion were not available for 2008 and 2010.

[d] Dashes indicate that no data were available either because data were missing or the variable was not an objective of the exercise.

Fig. 2. **Percentage of participating countries and areas completing IHR (2005) notifications and EIS postings during IHR Exercise Crystal, by year, 2008–2024[a]**



EIS: Event Information Site; IHR: International Health Regulations (2005).

[a] Data on IHR (2005) notifications and EIS posting completion were not available for 2008 and 2010. No exercise was held in 2009.

was observed over time, the mean performance was 73% for the 9 years of data (**Table 3**). Furthermore, where data were available, the proportion of NFPs engaging in multisectoral communication was lowest for the scenarios based on a radiological event, and vector-borne disease and non-influenza respiratory disease outbreaks caused by *Francisella tularensis* and novel coronavirus, and highest for infectious disease outbreaks involving a novel influenza virus or gastroenteritis (**Table 3**).

DISCUSSION

Since its beginning in 2008, IHR Exercise Crystal has seen strong participation from Member States in the Western Pacific Region, and several key NFP performance indicators have been tracked over time. Our analysis of these indicators demonstrates that the requirement for 24/7 accessibility of NFPs through their registered contact details continues to be a challenge. Email has proven to be the most effective means of communication, with a mean of 99% of NFPs successfully being contacted by email, compared with a mean of 64% of NFPs successfully being contacted by telephone. The proportion of NFPs who are able to join the exercise by tele- or videoconferencing has improved over time. These trends are consistent with previous findings about contacting NFPs in the Region[12] and demonstrate that while NFPs' performance has continued to improve, there remains a need to regularly test and update NFPs' contact details, at least annually. This is supported by a global survey of States Parties conducted in 2019, which found that communications was one of four critical areas in which NFPs experienced challenges.[13]

Similarly, our finding that the proportion of NFPs notifying simulated public health events to the WHO IHR Contact Point and the proportion of NFPs contributing information to EIS postings have improved over time is consistent with findings from other studies.[12–14] In a study of IHR (2005) States Parties, most (96%) NFPs reported that they were familiar with how to contact their designated WHO IHR Contact Point and that they had the necessary content expertise to discuss a notifiable event with the WHO IHR Contact Point.[13] In another study, 88% of NFPs reported that they had excellent or good knowledge of the Annex 2 decision-making instrument and either excellent (23%) or good (44%) ability to assess potential public health emergencies of international concern under Annex 2.[14] The strong performance in this NFP capacity is likely due to the long-term investments made by WHO and States Parties in institutionalizing the use of Annex 2 through training, guidance documents and standard operating procedures, as well as the development of legal, regulatory or administrative provisions supporting its use.[15–18] However, efforts should be continued to reinforce this capacity and ensure that it is consistently applied across all hazards. This need is highlighted by the decrease in EIS submissions during the 2023 Exercise Crystal, which featured a radiological event.

Our analysis did not find a clear trend in NFPs' capacity to engage in multisectoral communication; however, on average, 73% of NFPs communicated with another sector or agency during exercise play. It had been previously identified that NFPs experience challenges in intersectoral collaboration within their countries, including having limited access to or experiencing a lack of cooperation from key ministries[13] and that NFPs were not sufficiently empowered to carry out their functions,[13,19,20] which creates difficulties in engaging directly with other agencies or sectors and in triggering decision-making processes by national health authorities.[20] For these reasons, it has been recommended that States Parties establish a National IHR Authority that will focus on implementing the IHR (2005) across sectors at the national level, recognizing that the core capacities of the Regulations extend beyond the health sector.[20,21] Although the roles and functions of NFPs do not change under the June 2024 amendments,[3] the added requirement to designate or establish a National IHR Authority means that it will be even more important to ensure roles and responsibilities are clearly delineated and that States Parties develop, test and maintain up-to-date standard operating procedures, particularly in relation to multisectoral communication and coordination.

States Parties should also continue strengthening and empowering NFPs to conduct their core functions of IHR (2005) communications. Tools such as SPAR and IHR Exercise Crystal can guide continual improvements in NFP functionality, while highlighting the need for a critical foundation of supporting legislation and sufficient resourcing.[22] Furthermore, APHSAF advocates for strengthening the mandate and capacities of NFPs, by ensuring that they are prepared and ready to respond to public health emergencies (e.g. through regular testing), and by enhancing communication, information-sharing and coordination between the National IHR Focal Point system and emergency contacts for other areas and sectors, as well as between countries.[4]

Limitations of this analysis include the inability to capture multisectoral communications that occur outside of email communications observed during an exercise and variations over time in the methods used for monitoring and evaluating IHR Exercise Crystal. Therefore, it is important to consider triangulation with multiple data sources, such as SPAR, when analysing and interpreting the results of simulation exercises. Furthermore, as this study measured IHR (2005) communications in a simulation setting, actual NFP performance in real events may vary due to real-world complexities not reflected in the exercises.

Conclusions

Between 2008 and 2024, States Parties in the WHO Western Pacific Region demonstrated improved NFP capacities in the areas of IHR (2005) notification, contributing information to EIS postings, and participating in tele- and videoconferencing. Continued strengthening is required, particularly in the areas of NFP accessibility and multisectoral communications, alongside ongoing efforts to standardize data collection and assessments. Simulation exercises such as IHR Exercise Crystal are one tool that States Parties can use to assess NFP capacities and guide improvements. NFP functions do not change in the context of the IHR (2005) amendments and the designation or establishment of a National IHR Authority; however, States Parties should clearly define each entity's responsibilities, and develop and test operational procedures to ensure that NFPs continue to function without disruption. This is critical to advancing health security and IHR (2005) implementation in the Region.

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Conflicts of interest

GS is executive editor of the *Western Pacific Surveillance and Response* journal. She was not involved in the editorial decision to publish this article. The other authors have no conflicts of interest to declare.

Ethics statement

This regional analysis consists of a review and synthesis of openly available public health data. It does not involve human participants, identifiable personal data or interventions. Based on organizational ethical review policies, such activities do not require formal ethics approval.

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