


# How can early COVID-19 vaccine campaigns in the US-affiliated Pacific Islands inform future vaccine efforts: a cross-sectional analysis

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## ABSTRACT

**Introduction** The US-affiliated Pacific Islands (USAPI) are six geographically isolated and culturally distinct Pacific Island jurisdictions with special relationships with the USA; the USAPI were included in the US COVID-19 vaccination effort. This study documents the approaches and lessons learnt from the rollout of COVID-19 vaccination in the USAPI, including four COVID-19-free jurisdictions.

**Methods** Quantitative data regarding vaccination administration were obtained from each jurisdiction's immunisation information systems during 13 December 2020 and 11 March 2021. USAPI and US county-level vaccination administration rates by age group from the CDC were compared. Qualitative data regarding key components of the vaccination efforts were collected by survey from each USAPI lead immunisation manager.

**Results** A total of 90 870 individuals aged ≥16 years in the USAPI received at least one dose of vaccine during 17 December 2020 to 11 March 2021 (28.2% of the eligible population). Most jurisdictions observed rapid vaccine uptake after introducing COVID-19 vaccines and fully vaccinated >20% of their eligible populations in 3 months or less. During the study period, the USAPI region achieved higher coverage than the rest of the US once all USAPI had begun vaccination. All jurisdictions identified pre-campaign community messaging outreach as key to success and misinformation and rumours as the most common challenge. The lessons reported by USAPI immunisation managers included the need for quality risk communication and sustained involvement of interdisciplinary partners.

**Conclusion** Tailoring vaccine administration and communication strategies to each jurisdiction while maintaining system agility was critical for success, particularly considering the logistical challenges presented by the geographic remoteness of the USAPI. Maintenance of the jurisdictions' planning preparedness efforts, newly installed infrastructure and local partnerships can strengthen the resilience of the jurisdictions for a range of challenges beyond the COVID-19 response. Future immunisation strategies should build from the successful vaccination plans showcased here.

## WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The early stages of the global COVID-19 vaccine effort highlighted challenges in vaccine equity and vaccine delivery. During initial rollouts, the six US-affiliated Pacific Islands (USAPI) were recognised among countries with the highest vaccine coverage in the world. Despite this, little has been documented about the implementation strategies of COVID-19 vaccination in these small island jurisdictions.

## WHAT THIS STUDY ADDS

⇒ This evaluation summarises the approaches, successes, challenges and key lessons learnt from the early rollout of COVID-19 vaccination in the USAPI, including COVID-19-free communities.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The experiences from the USAPI COVID-19 vaccine rollouts are essential lessons that can be used to navigate the early stages of future vaccine rollouts in island nations and other geographically remote areas around the world. These strategies highlight the use of tailored vaccination strategies building from pre-existing vaccine preparedness plans, early community education and engagement, adaptive communication plans to rapidly address misinformation, and flexible strategies to respond to changes in demand and resource constraints.

## INTRODUCTION

The US-affiliated Pacific Islands (USAPI) are composed of six island jurisdictions with special relationships with the USA. There are three US territories: American Samoa, the Commonwealth of the Northern Mariana Islands (CNMI) and Guam; and three independent countries that have negotiated agreements with the USA: the Federated States of Micronesia (FSM), the Republic of Palau

(Palau) and the Republic of the Marshall Islands (RMI). Of note, FSM has a unique political composition with a national government and four independently governed states: Chuuk, Kosrae, Pohnpei, and Yap.

The USAPI comprise hundreds of small, remote islands within an area spanning millions of miles of ocean and are home to over 500 000 people.<sup>1</sup> Most live on a few more densely populated islands, and approximately 55 000 people live on remote outer islands and atolls. FSM and RMI have larger proportions of their populations that live on outer islands, with estimates of 35% in Yap, 26% in Chuuk, 26% in RMI and 4% in Pohnpei (there are no outer islands in Kosrae).<sup>2,3</sup>

The agreements between the USA and Palau, FSM and RMI fall under the Compact of Free Association and provide these independent countries support from the USA that includes access to US domestic public health programmes, including public health emergency preparedness, hospital preparedness, epidemiology and laboratory capacity development, and childhood immunisation.<sup>4</sup> In addition, all six USAPI receive support from international partner agencies such as the WHO, the Pacific Community (SPC) and the Pacific Island Health Officers Association (PIHOA).

As a result of the special relationship the USA has with the USAPI, all jurisdictions were included in the US COVID-19 effort initially named Operation Warp Speed.<sup>5</sup> Each of the six USAPI were provided financial support from the USA through the US Centers for Disease Control and Prevention (CDC) to initiate planning and preparation for a potential vaccine. All USAPI were provided the same pro rata in proportion to population distribution of vaccines as the 50 states, and in December 2020, the USAPI started to vaccinate their populations against COVID-19. Unlike the rest of the USA, which received weekly allotments (except Alaska), the region received a monthly allocation of vaccine doses, inclusive of first and second doses, typically in large shipments. Due to their small populations and remote locations, weekly allotments for USAPI would have been very small and weekly shipments logistically challenging.

The jurisdictions prioritised vaccine doses according to CDC recommendations for phased rollout based on risk for COVID-19-associated morbidity and mortality and work-related exposure to SARS-CoV-2.<sup>6</sup> The phases used included phase 1a—healthcare workers and long-term care facility (LTCF) residents; phase 1b—75 years and above, first responders and frontline essential workers; phase 1c—65 years and above, 16–64 years with high-risk conditions and other essential workers; phase 2—40 years and above; and phase 3—18 years and above or 16 years and above based on vaccine product. During December 2020 to February 2021, Pfizer-BioNTech and Moderna COVID-19 vaccines were the only two available. In March 2021, the Janssen COVID-19 vaccine was made available to the islands. The three vaccines have different storage requirements: Pfizer-BioNTech requires ultra-low temperatures for storage between  $-80^{\circ}\text{C}$  and  $-60^{\circ}\text{C}$

( $-112^{\circ}\text{F}$  to  $-76^{\circ}\text{F}$ ); Moderna is stored between  $-25^{\circ}\text{C}$  and  $-15^{\circ}\text{C}$  ( $-13^{\circ}\text{F}$  to  $5^{\circ}\text{F}$ ) but can be stored refrigerated between  $2^{\circ}\text{C}$  and  $8^{\circ}\text{C}$  ( $36^{\circ}\text{F}$  and  $46^{\circ}\text{F}$ ) for up to 30 days before first use; and Janssen is provided and stored refrigerated at  $2^{\circ}\text{C}$  to  $8^{\circ}\text{C}$  ( $36^{\circ}\text{F}$  to  $46^{\circ}\text{F}$ ).<sup>7-9</sup>

Despite their inclusion as part of the US vaccination efforts, these jurisdictions' demographic, geographic, political and economic characteristics have more in common with other Pacific Island Countries and Territories (PICTs) than with the 50 US states. Like many other PICTs, the USAPI are composed of geographically isolated, culturally distinct populations with a higher burden of non-communicable diseases than the USA.<sup>10</sup> Yet, the US commitment to provide equal support to the USAPI as that provided to the US states for COVID-19 immunisation meant that these island jurisdictions received and implemented COVID-19 vaccination programmes before the rest of the Pacific.

Since the first recognition of the potential global threat of SARS-CoV-2, the USAPI have engaged in key preparedness activities, focusing on prevention. By leveraging the unique characteristics of island jurisdictions, primarily the inherent isolation of island communities, many PICTs prevented the introduction of SARS-CoV-2 through rigorous interventions at points of entry. Only two of the six USAPI had detected local transmission of SARS-CoV-2 in their communities by the end of March 2021 (Guam and CNMI).<sup>11,12</sup> The other USAPI also prevented the introduction of SARS-CoV-2 through similar border measures with a spectrum of interventions, including complete border closures, strict pre-departure and arrival quarantine and testing requirements, and arrival-only quarantine systems with testing requirements.<sup>13-17</sup>

During the early stages of the COVID-19 vaccine rollout, the USAPI were recognised for having some of the best vaccination coverage in the US COVID-19 vaccination effort.<sup>18</sup> The objective of this study was to better understand the initial implementation of the USAPI immunisation programmes and identify their reasons for success. This evaluation documented the approaches, challenges and key lessons learnt from the rollout of COVID-19 vaccination in the USAPI. These findings can better inform vaccination initiatives in island jurisdictions around the world.

## METHODS

Quantitative data regarding vaccination were obtained from each jurisdiction's immunisation information systems (IIS) during 13 December 2020 and 11 March 2021. These data included total doses delivered, total doses administered, estimated vaccination coverage, the number of first and second doses administered by day, the 7-day moving average of vaccine administration, the proportion of second doses that were administered on-schedule and vaccine coverage by age group for each jurisdiction. On-schedule administration was calculated for each second dose administered based on product,

using vaccine recommendations as of March 2021: 17–42 days after dose 1 for Pfizer-BioNTech and 24–42 days after dose 1 for Moderna. As the Janssen COVID-19 vaccine was made available in the USAPI after the study period, it was not included in this analysis. The proportion of second doses administered on-schedule includes only people who have received a second dose. The number of total doses received and vaccination coverage by geographic location were extracted from the Pacific Weekly Situation Report produced by PIHOA and CDC.

For each jurisdiction, 2021 mid-year population projections from the Pacific Data Hub were used as population denominators for determining vaccination coverage.<sup>19</sup> Eligible population denominators were extrapolated from the 5-year age cohorts using average population bins to estimate populations. The eligible population was defined as the estimated population of the jurisdiction for which a vaccine issued an Emergency Use Authorization by the US Food and Drug Administration was available in that jurisdiction during the study period: ages 18 years and above for jurisdictions with Moderna product only (Palau, FSM and RMI) and ages 16 years and above for jurisdictions with both Moderna and Pfizer-BioNTech products (American Samoa, CNMI, and Guam).

To determine the success of the USAPI vaccination programmes in administering vaccines to populations of focus as defined in the Advisory Committee on Immunization Practices' interim vaccine allocation guidelines, county-level vaccination data by age group from the CDC was used to compare vaccine coverage between the USAPI and the rest of the USA.<sup>6,20</sup> Immunisation coverage among healthcare workers and individuals with co-morbidities at the highest risk of serious COVID-19 outcomes was not available for both the USAPI and the USA; thus, coverage in these demographics was not evaluated.

In February 2021, a survey was developed by local partners through a combination of de novo questions and utilising and modifying existing immunisation programme evaluation survey instruments (CDC, unpublished). The survey was designed to capture qualitative data regarding various key components of the COVID-19 vaccination efforts, including community engagement, communication strategies, data collection and entry, and operational logistics (including cold chain management, organisational structure, vaccine and ancillary supply, and financial support).

The survey consisted of 21 items in four content domains: (1) overall feedback from the COVID-19 vaccine rollout, (2) external partner support, (3) community preparedness activities and (4) planning and logistics. The survey included multiple choice, short answer and Likert style questions. Pilot testing indicated that it took approximately 15 min to complete. The survey was administered to the lead immunisation manager in each of the six USAPI via Survey123 over a 2-week period in March 2021 (online supplemental material 1). In addition to the formal survey, we solicited feedback from COVID-19 response partners (eg, public health staff

and clinicians) through informal interviews on regularly occurring support calls.

To determine key approaches and lessons learnt perceived by immunisation managers, qualitative data generated from the survey and informal interviews were analysed using inductive and deductive analysis approaches. Freeform answers were coded line by line to identify broad-level themes. Under the four content domains, thematic analysis to determine pattern themes was also conducted.<sup>21</sup>

Quantitative survey analysis included frequency and proportion of answer choices for multiple choice questions, yes or no questions, and Likert style questions. Jurisdictions reported areas where external partner support was needed, where it was received and where more support was needed. The findings were tabulated by jurisdiction to calculate areas where support was needed and received, where support was needed and not received, and where support continued to be needed at the end of data collection for each jurisdiction.

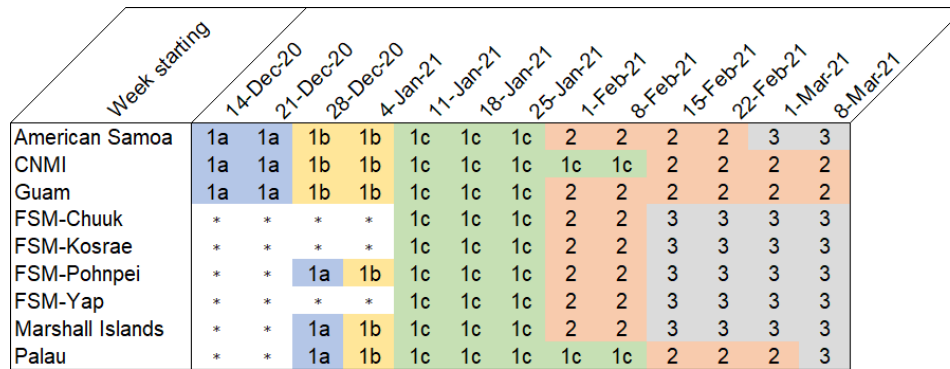
## RESULTS

### Summary of vaccination campaigns

A total of 90 870 individuals aged  $\geq 16$  years in the USAPI received at least one dose of vaccine during 17 December 2020 to 11 March 2021 (28.2% of the eligible population), with a total of 153 773 doses of vaccine administered. During the initial vaccination effort, Pfizer-BioNTech and Moderna vaccines were available to the USAPI. Due to the additional logistics and equipment required to maintain the ultra-low temperature associated with the Pfizer-BioNTech vaccine, three jurisdictions (FSM, Palau and RMI) opted out of Pfizer-BioNTech and only received Moderna. Guam, CNMI and American Samoa administered both Pfizer-BioNTech and Moderna vaccines.

Using the CDC's vaccine prioritisation framework, each jurisdiction moved from phase 1a to phase 3 based on their independent demand and uptake patterns (figure 1). Most jurisdictions began in phase 1a, vaccinating healthcare workers and long-term LTCF residents (in Guam only, as the other USAPI do not have official LTCFs), and added phase 1b within 2 weeks of campaign start, vaccinating those 75 years of age and older, first responders and frontline essential workers. Three FSM states (Chuuk, Kosrae and Yap) began their campaigns with eligibility to individuals in phases 1a through 1c after receiving vaccines from Pohnpei, FSM's central hub of vaccine shipping.

All jurisdictions except RMI implemented large central points of dispensing (PODs) as the main distribution point with several additional types of PODs to improve access to COVID-19 vaccination for all people and to assist in targeting vaccines to priority groups. RMI primarily administered vaccines through small decentralised PODs, mobile PODs and door-to-door activities. CNMI, Guam and FSM also augmented community outreach through add-on mobile and/or temporary PODs (table 1).



**Figure 1** Prioritisation of COVID-19 vaccine doses† by jurisdiction in the US-affiliated Pacific Islands (USAPI) from 17 December 2020 to 11 March 2021. Phases: 1a—Healthcare workers and long-term care facility residents; 1b—75 years of age and older, first responders and frontline essential workers; 1c—65 years of age and older, 16–64 years with high-risk conditions and other essential workers; 2—40 years of age and older; 3—18/16 years of age and older. †COVID-19 vaccine products available in each jurisdiction during the period: Moderna product only (FSM, Palau and RMI); both Moderna and Pfizer-BioNTech products (American Samoa, CNMI and Guam). \*Not actively vaccinating.

**Table 1** Summary of vaccine administration activities by jurisdiction from 17 December 2020 to 11 March 2021

Vaccine administration metrics	American Samoa	Commonwealth of the Northern Mariana Islands	Federated States of Micronesia	Guam	Republic of Palau	Republic of the Marshall Islands
Vaccine distribution modality	One large central POD	One large central POD, mobile PODs	One large central POD, targeted PODs	One large central POD, small decentralised PODs, targeted PODs, temporary off-site POD	One large central POD	Small decentralised PODs, door-to-door outreach, mobile PODs
Product(s)	Moderna, Pfizer-BioNTech	Moderna, Pfizer-BioNTech	Moderna	Moderna, Pfizer-BioNTech	Moderna	Moderna
Total number of vaccine doses delivered	43210	43 610	46600	87 360	14 600	35 000
Total number of vaccine doses administered	25793	21 629	18860	61 005	9198	17 288
Average number of vaccine doses administered per day	318	264	269	762	137	240
Highest throughput of vaccine doses in a single day	1538	517	680	2349	643	772
Total number of individuals (per cent of eligible population) with at least one dose*	15 172 (40.4%)	12 625 (28.9%)	11 677 (17.5%)	33 583 (25.7%)	6097 (44.3%)	11 716 (38.4%)
Total number of individuals (per cent of eligible population) fully vaccinated*	10 620 (28.3%)	9002 (20.6%)	7183 (10.8%)	27 414 (21.0%)	3101 (22.6%)	5570 (18.3%)
Total number (per cent) of second doses administered on-schedule†	10 573 (99.6%)	8993 (99.9%)	7148 (99.5%)	27 264 (99.5%)	3101 (100%)	5426 (97.4%)

\*The eligible population for which per cent was calculated is defined as the estimated population of the jurisdiction ages 18 and above for jurisdictions with Moderna product only and ages 16 and above for jurisdictions with both Moderna and Pfizer-BioNTech products.  
 †On-schedule administration was calculated for each second dose based on product—17–42 days from dose 1 for Pfizer-BioNTech and 24–42 days from dose 1 for Moderna.  
 POD, point of dispensing.

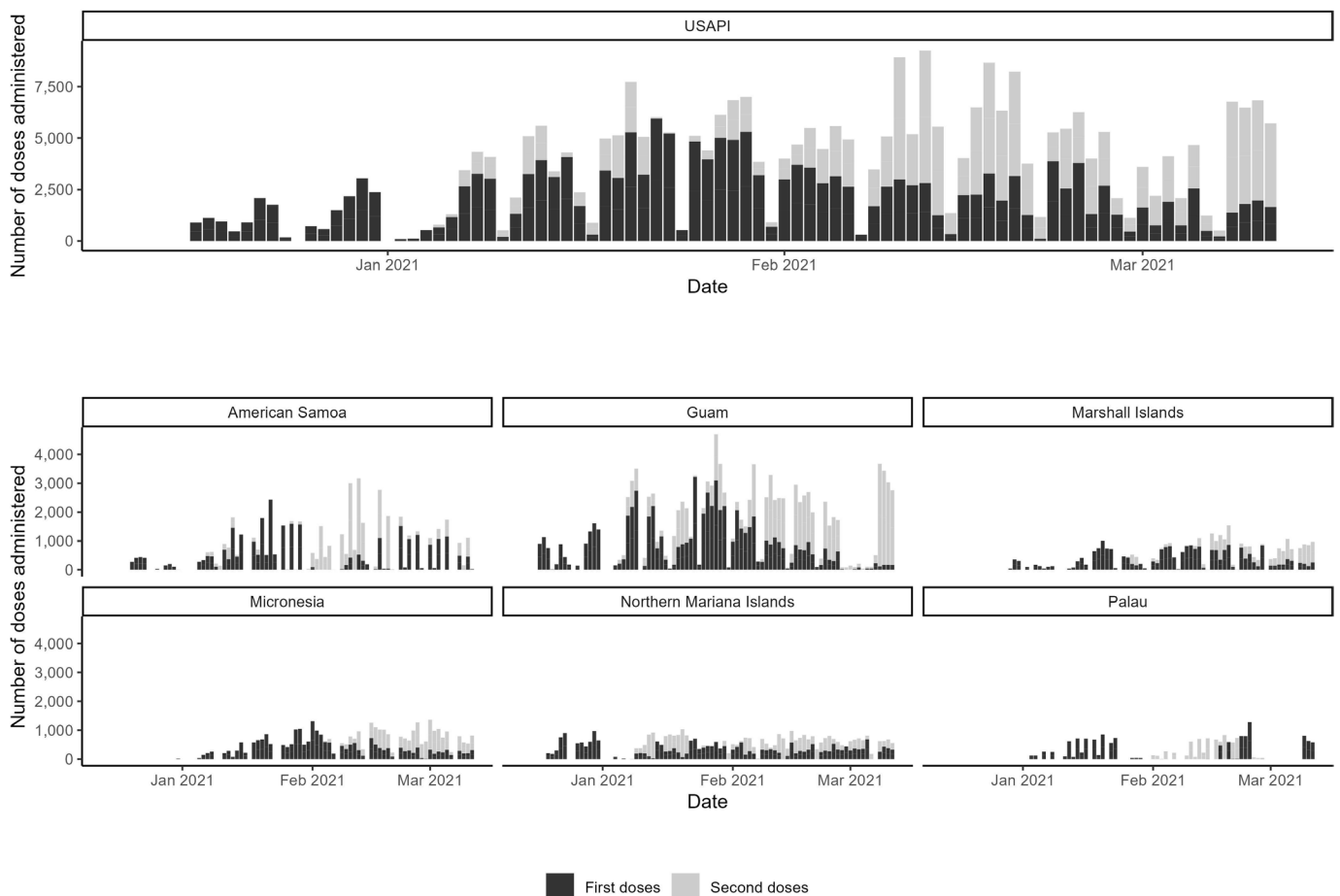
Palau and American Samoa achieved the highest number of vaccine doses administered per capita (66 890 per 100 000 eligible population and 68 760 per 100 000 eligible population, respectively) and highest coverage with at least one dose (44.3% and 40.4%) among the USAPI as of 11 March 2021 (table 1). Notably, the USAPI had high rates of on-time administration of second doses among those who received a second dose despite the unique geographical barriers to achieving such coverage (table 1).

### Trends in initial vaccination campaigns, 17 December 2020 to 11 March 2021

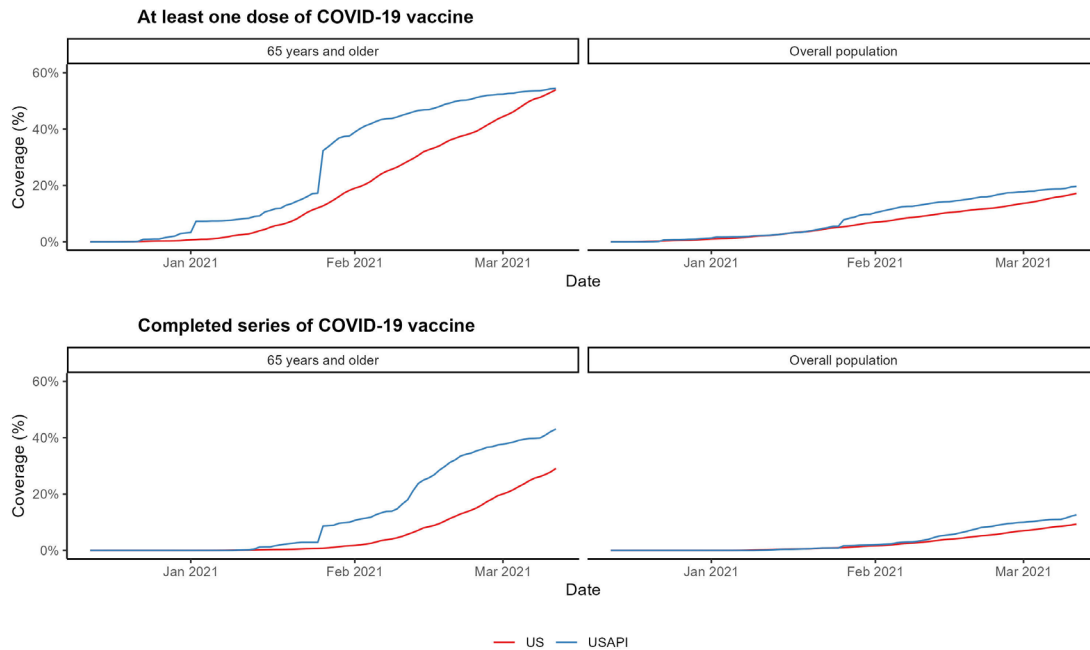
COVID-19 vaccination in the USAPI began shortly after the USA started on 14 December 2020: first in Guam on 17 December, followed by CNMI on 19 December, American Samoa on 20 December, RMI on 29 December, FSM on 31 December and Palau on 3 January 2021. Vaccine administration trends were affected by vaccine delivery trends (online supplemental figure 1). The region saw a rapid increase in doses administered with progressive increases monthly, except for March. From late February into early March, a marked decrease in vaccine doses administered daily in the USAPI was driven primarily by decreases observed in Guam and Palau, which had administered almost all their available doses.

American Samoa and Palau oscillated between administration periods where almost all doses administered were first doses, followed by a period almost exclusively administering second doses (figure 2). CNMI, FSM, Guam and RMI displayed mixed administration of first and second doses after the first wave of first doses were administered.

After all the USAPI had initiated vaccination, the USAPI region reached a higher coverage of at least one dose and series completion than the rest of the USA within a few weeks, among the overall population and those aged 65 years and above—a group at high risk of severe disease (figure 3). By 11 March 2021, the USAPI led the USA in vaccine coverage with at least one dose (among the overall population: 19.7% vs 17.2%; among those ages 65 and above: 54.4% vs 53.9%) and series completion (among the overall population: 12.6% vs 9.4%; among those ages 65 and above: 43.1% vs 29.1%). By jurisdiction, American Samoa, CNMI, Guam and Palau maintained higher vaccination coverage than the USA across all these categories during the period, with the region reaching higher coverage in all four categories. These four USAPI also performed well compared with the 3275 non-USAPI US counties individually, with all four reporting vaccine coverage at or above 90% of counties for at least three of the four categories on 11 March 2021.



**Figure 2** Daily count of first and second doses of COVID-19 vaccine administered in the US-affiliated Pacific Islands (USAPI) from 13 December 2020 to 11 March 2021.



**Figure 3** COVID-19 vaccine coverage among those aged 65 years and older and the overall population by dose in the US-affiliated Pacific Islands (USAPI) and the USA from 13 December 2020 to 11 March 2021.

FSM and RMI reported coverage below 50% of counties across all categories, though the COVID-19 vaccine was not yet available in the outer island areas whose populations were included in the denominator.

**Vaccination coverage by age group**

Most jurisdictions achieved relatively high vaccination coverage with at least one dose of vaccine among individuals 55 years of age and above (table 2).

CNMI, Guam and Palau achieved the highest coverage among older age groups, with decreasing coverage in younger age groups. American Samoa exhibited similar coverage for all age groups above 30 years, with these age groups achieving over 50% coverage. This trend is also found in FSM, though coverage achieved is lower,

with around 20% coverage for these age groups. RMI is the sole jurisdiction that had a different trend, where coverage was highest among those ages 40–49 years and decreased among age groups of increasing age.

**Communication strategies**

All jurisdictions reported using public service announcements (PSAs), flyers/posters, partnerships with community organisations and social media to provide information about COVID-19 vaccination to the public (online supplemental table 1). Other common strategies included community outreach events (n=5) and banners (n=4). Three jurisdictions noted additional unique strategies, which included roadside billboards, a nationwide

**Table 2** Vaccination coverage with at least one dose of COVID-19 vaccine by age group in the US-affiliated Pacific Islands (USAPI) for eligible populations as appropriate by jurisdiction\* using 2021 mid-year population estimates, as of 11 March 2021

Age group	American Samoa		Commonwealth of the Northern Mariana Islands		Federated States of Micronesia		Guam†		Republic of Palau		Republic of the Marshall Islands	
	n	%	n	%	n	%	n	%	n	%	n	%
65+	2061	51.8	2196	46.8	1277	22.3	11 346	58.9	1358	74.4	856	39.6
60–64	1357	55.7	1605	41.1	899	23.6	4862	54.5	643	60.1	635	49.5
55–59	1655	54.3	1822	38.1	1030	23.7	4481	41.7	719	54.3	802	48.6
50–54	1702	55.0	1431	26.8	1227	25.2	3039	27.2	685	46.1	1098	57.9
40–49	3074	57.6	2066	27.0	2561	22.2	4188	20.8	1172	41.6	2647	58.4
30–39	2368	52.1	1798	38.7	2314	16.6	2911	13.4	899	36.6	2696	39.4
20–29	2056	20.1	1600	17.6	2037	11.1	2576	9.2	604	26.1	2576	26.9
16–19	899	18.5	107	2.9	332	4.1	178	1.6	17	1.9	406	7.9
Overall	15 172	40.4	12 625	28.9	11 677	16.5	33 583	25.7	6097	42.9	11 716	35.4

\*The eligible population for which per cent was calculated is the estimated population of the jurisdiction ages 18 and above for jurisdictions with Moderna product only (FSM, Palau and RMI) and ages 16 and above for jurisdictions with both Moderna and Pfizer-BioNTech products (American Samoa, CNMI and Guam). †Age values were missing for two doses administered in Guam; thus, its column totals two fewer than the overall number of vaccines administered.

text messaging campaign, and a partnership with a government communication team.

Jurisdictions also identified communication types that worked well based on community feedback and the jurisdiction's perception. Three jurisdictions identified social media—particularly Facebook, a popular platform in the islands—as a suitable communication type, with one specifically noting an increase in followers during the pandemic ('Information sharing via Facebook has been effective'; 'During outreach events and Facebook live events, community are encouraged to ask questions related to COVID-19, vaccination and repatriation'). Some stated the importance of having diverse, innovative communication schemes for different island settings, with one particularly noting the strength of word-of-mouth compared with messaging through newer platforms, which may have geographical and technological barriers ('When we conduct house to house vaccination, the nurses and volunteers are giving out information on the vaccination which made the family or individual at ease and informed. Word of mouth or oral communication is strong in our community. They liked to get informed in a personal manner. New technology today is an advantage but might not reach the high-risk population because (of) their location if geographically and technologically challenged'.) Only one jurisdiction identified a communication type that did not work well overall for their campaign: flyers and posters were not very effective; these materials were frequently discarded ('Flyers and posters didn't work well because the people tend to throw them away and some don't read them'.) and suggested community outreach events, social media and PSAs as methods that worked well instead.

### Planning and logistics

All six USAPI utilised pre-existing vaccine preparedness plans during the initial COVID-19 vaccine rollout, including plans from previous vaccination efforts and playbooks developed explicitly for the COVID-19 vaccination rollout in the fall of 2020. All six jurisdictions reported at least moderate changes to their logistics plans after the start of their vaccine rollout, with two reporting substantial changes and one reporting having to change their rollout plans completely. Reasons for changes to logistical plans included adjustments to fit the island settings better, incorporating lessons learnt from recent vaccination campaigns ('The department has lessons learned from the measles outbreak [in 2019] that caused the program to ensure protocols were in place'), resource availability, changing planned vaccine administration methods ('We have to change our plan to conduct COVID-19 vaccination to house to house method instead of stationary PODs') and delegation of logistics responsibilities to another entity within the emergency management structure.

During the initial rollout, other factors that necessitated further adaptations to the logistics plans in the six jurisdictions included vaccine supply (n=2), low uptake

in vaccine (n=2) and policy decisions or changes (n=2). To address these factors, jurisdictions reported adaptations to enhance their immunisation activities after implementing their initial vaccine campaigns. One jurisdiction that noted leadership decisions and short funding expenditure timelines as reasons that their plans changed mentioned that they found success in focusing on improvements to cold chain infrastructure and adapting monitoring and registration systems. Another jurisdiction noted that the increased funding and quantity of vaccines resulted in them changing their original plans to increase their throughput with these additional resources and reported implementing an appointment registration system, large POD at a local university gym, hiring more vaccinators and updating their jurisdiction's standing order to cover 'any licensed or certified [health-care provider] trained to administer COVID-19 vaccine'.

Some jurisdictions reported factors that necessitated changes to their vaccination plans that did not have identifiable strategies to overcome during the study period. One jurisdiction identified the type of vaccine supplied as a primary reason for plan changes, with the less sensitive Janssen vaccine not yet available during the study period ('sensitive vaccine (is) unable to do outreach activities in remote areas, ... awaiting more supply of less sensitive Janssen vaccine to support and increase uptake'). Some jurisdictions mentioned the difficulty with planning for vaccination activities in remote islands, with one pointing to difficulty planning without accurate allocation numbers ('Without knowing vaccine allocation for at least 6 months, it is hard for us to create and implement a sound plan especially to the Outer Islands with the consideration of transportation and location').

### Strategies for success, challenges and lessons learnt

#### Strategies for success

All jurisdictions identified pre-campaign messaging outreach with the community through their identified communication strategies as a key to their success (online supplemental table 2). Jurisdictions reported several additional factors that were key to success. First, FSM and RMI reported prioritising populations on main islands (who were at highest risk of exposure to disease as travel hubs) as a key to their local success, noting the lack of a suitable vaccine to make the boat trip and maintain cold chain. Second, multiple jurisdictions indicated the importance of multi-sectoral collaboration with local, federal and international partners to support vaccination efforts to procure necessary supplies and expand the vaccination workforce, with several noting the use of the Incident Command Structure (ICS) to facilitate coordination ('Have key partners engaged before and throughout the campaign'; 'Use... the ICS structure for planning and rollout'). Third, reaching people at higher risk for serious COVID-19 outcomes was a priority for several jurisdictions, noting the use of house-to-house messaging to reach high-risk populations and increase their uptake. Lastly, several jurisdictions mentioned the importance

of accurate record keeping, including ensuring training on the jurisdiction's IIS and integrating reporting to the CDC.

### Challenges

The most commonly reported challenges to vaccination efforts in the USAPI were misinformation and rumours in the community, with two-thirds of jurisdictions noting these as challenges (online supplemental table 3). Three jurisdictions indicated that addressing rumours in the community was one of their strategies for success; however, two of these jurisdictions indicated that misinformation and rumours were ongoing challenges to the campaign. One example of a rumour shared online among the local communities included attributing the death of family members in the islands or US states to recently receiving the vaccine.

Another challenge reported by the USAPI in their vaccination campaigns was vaccine administration. Three jurisdictions reported inconsistent vaccine supply due to challenges with shipping of the vaccine and changes in the size of monthly allocations and demand, with vaccine hesitancy reported among healthcare workers, an early priority group. Inconsistent supply led to some jurisdictions exhausting available doses weeks before the next shipment and lacking clarity on expected arrival of additional inventory to plan complex vaccination campaigns. In addition, several immunisation managers mentioned that they needed visibility on the number of allocated vaccine doses for planning.

Other challenges shared by multiple jurisdictions were maintaining the cold chain and financing difficulties. The two jurisdictions that reported cold chain infrastructure as a challenge also indicated that finding solutions to cold chain challenges was one of their keys to success. The resolution reported by these jurisdictions was to work with partners and local providers to ensure sufficient infrastructure for the vaccine in central depots and with providers administering the vaccine (eg, freezers, refrigerators, data logs, and transport).

Several jurisdictions reported challenges unique to their vaccine campaign. One jurisdiction indicated challenges with vaccine ancillary supply (eg, vaccine ancillary kits containing needles, syringes, alcohol pads and vaccination cards), which was tied closely to a need for additional vaccine supply as this jurisdiction reported administering vaccine faster than they could receive it. One jurisdiction reported data capture and use challenges and suggested improving data processes, including establishing data use agreements with local immunisation data partners and the CDC. The jurisdictions that each reported staffing and human resource challenges, geographically isolated populations and backlogs in off-island vendors of necessary supplies did not report any successful approaches to addressing these challenges during the period.

### Lessons learnt

Qualitative analysis of responses from USAPI immunisation managers regarding lessons learnt and things they wish they had known prior to rollout yielded the following themes: the need for quality risk communication, sustained involvement of interdisciplinary partners, and jurisdiction-specific lessons learnt (online supplemental table 4).

Several jurisdictions noted the importance of simple, high-quality risk communication to the community with adequately trained risk communication teams, noting the need for patience and reliability when communicating with the public. One jurisdiction reported that they wish they had known about vaccine hesitancy among healthcare workers and younger age groups.

One jurisdiction's lesson learnt was the need to involve 'all partners, community groups, non-governmental organizations (NGOs), church groups, youth groups, and other sectors' to support their vaccination efforts. In addition, several jurisdictions reported the need to receive buy-in and support from local leaders from the beginning and throughout the vaccination campaign. Several jurisdictions mentioned the need for additional staff, with one advising to 'get all the help you can possibly get; acquire additional support staff for IIS [Immunisation Information System] training, vaccine training, and communications'.

### External partner support

Many external partners were involved in the initial rollout of the COVID-19 vaccine in the USAPI. The USAPI listed the following external partners as being involved in their immunisation campaigns: CDC, WHO, Health Resources and Services Administration (HRSA), United Nations International Children's Emergency Fund, Federal Emergency Management Agency, PIHOA, US Environmental Protection Agency (EPA), World Bank, Republic of China-Taiwan, International Organization for Migration (IOM) and the International Committee of the Red Cross.

The USAPI received external support in the following 11 areas: communications and educational material development, finance, cold chain, community preparation, human resources and support staff, vaccine and ancillary supplies, clinical support, data collection and use, logistics, training, and onsite technical assistance (online supplemental table 5). Partner support resulted in long-term results (areas where support was reported as received and not reported as needing further support) in at least half of jurisdictions that reported needing support in communication and educational material development, clinical support, data collection and use, logistics, training and onsite technical assistance. Most jurisdictions (n=5) indicated that at least one area where they received support still needed more support. All jurisdictions reported needing further support from external partners in at least two support areas.



## DISCUSSION

Most jurisdictions observed rapid vaccine uptake after introducing COVID-19 vaccines to the USAPI in December 2020 and January 2021. As a region, the initial vaccination efforts were largely successful by administering more vaccines per capita (both first doses and complete series) than the rest of the USA. Most jurisdictions fully vaccinated >20% of eligible populations by March 2021, though FSM achieved 10.8% total coverage among its eligible population.

For the USAPI, each jurisdiction tailored their vaccine playbooks to the type of vaccine they chose to receive; ease of vaccine delivery and maintenance was important in vaccine choice. Half of the jurisdictions declined the Pfizer-BioNTech vaccine, generally jurisdictions with more expansive geographic areas and limited infrastructure for ultra-low temperature vaccine storage (Palau, RMI and FSM). However, limitations caused by the ultra-low temperature storage requirement extended to jurisdictions that chose to receive the Pfizer-BioNTech vaccine. Most had few freezers capable of ultra-low temperatures and had to quickly procure additional freezers and coordinate between local healthcare providers to adequately distribute the vaccine. Although all jurisdictions had pre-existing vaccine preparedness plans, most reported at least moderate changes informed by on-the-ground challenges and needs.

Tailoring vaccine administration strategies to each jurisdiction was critical for success. Jurisdictions used two distinct administration strategies for first and second doses: staggered and simultaneous. Jurisdictions with the highest throughput (American Samoa and Palau) administered first and second doses in staggered periods, while other jurisdictions took a mixed approach, administering both first and second doses simultaneously. Once individuals were eligible for a second dose in American Samoa and Palau, they administered only second doses until all individuals who received the first dose had completed the series. By contrast, vaccine activities in other jurisdictions administered second doses to eligible individuals while simultaneously administering first doses to new individuals. Monthly batching of vaccine allotments may also encourage using doses allocated as second doses as early first doses when there is high demand. The early-use strategy necessitated continued vaccine supply to ensure on-time administration of second doses, which was possible with the monthly vaccine allotments from the US COVID-19 effort. However, this strategy resulted in spikes in vaccine administration after receipt of monthly allocations and subsequent rationing of doses later in the month.

Systems needed to be agile to respond to shifting demands and crucial groups with changes to plans during the rollout. Adapting the vaccination activities based on the stages of demand appeared to maximise programme efficiency of rapidly achieving high coverage in populations at the highest risk of serious COVID-19 outcomes. When the demand for the vaccine was high

(primarily during the early stage of the campaign), large centralised PODS with a scheduling system successfully achieved high vaccine administration rates in all jurisdictions with major population centres. As demand slowed, different approaches to increase access to vaccines by critical populations and remote communities were implemented, including mobile, temporary, or door-to-door PODs and outreach efforts.

The vaccine rollout was initially limited by supply from the monthly allocation system unique to the USAPI and Alaska, not the demand or jurisdictional immunisation capacity. Many jurisdictions reported running out of vaccine doses before they received their next monthly allocation during the initial rollout due to enhanced efficiency of planning and delivering vaccines in their communities. For example, vaccine shortages in Guam and Palau contributed to the marked decrease in the number of doses administered observed in late February into early March. In addition to the challenges of planning around monthly allocations, logistical challenges in delivering vaccine doses to the USAPI and subsequent delivery to their remote outer islands resulted in planning uncertainty and delays. These logistical challenges contributed to differences between the number of doses delivered and the number of doses administered, often observed after receipt of their monthly allocation.

Jurisdictions rapidly loosened the requirements of accessing the vaccine within 3 months of the programme start. By 1 March 2021, American Samoa, FSM and RMI opened eligibility for the vaccine to all age groups. By the same time, CNMI, Guam and Palau allowed all priority groups recommended by the CDC and anyone aged 50 and above to receive the vaccine, while most US states remained in phase 1c or a variation with eligibility restricted to those 65 years and above.<sup>22</sup> Most jurisdictions successfully prioritised older age groups, with the highest coverage in these older age groups. Unlike the other five USAPI, RMI's coverage was highest among middle age groups, with lower uptake in older age groups. This pattern is likely due to the rapid removal of vaccine prioritisation eligibility requirements in RMI, which was the first USAPI to lift all vaccine eligibility restrictions. Within 6 weeks of the campaign's start, all individuals in RMI were eligible to receive a COVID-19 vaccine approved for their age group. RMI justified its early expansion of vaccine eligibility groups because of the high demand and absence of local transmission of SARS-CoV-2. The lower coverage among older age groups who are at the highest risk of severe disease was likely an unintended outcome of the prioritisation recommendations and complicated by the use of outdated denominator data from the 2010 US Census in reporting.

All jurisdictions reported that using sound risk communication techniques to overcome misinformation was key to the high rate of vaccine administration, chiefly because misinformation and rumours were primary challenges reported by campaigns. Preparing the community before the vaccination campaigns with key messaging was

a cornerstone of programme success across the USAPI. All the risk communication campaigns garnered cross-government and other societal support partners. In addition, real-time communication issues needed to be anticipated and addressed. The jurisdictions with the highest coverage rates (Palau and American Samoa) reported proactive messaging and communication campaigns to address adverse events (true or coincidental) and misinformation in real time, such as with social media. Traditional and technological approaches to communications worked well across the USAPI. However, the campaigns tailored to the islands (eg, language, culture, environment and local concerns) and delivered through diverse communication channels were the most successful. In many of the islands, geographical and technological barriers can limit the use of newer communication platforms, and word-of-mouth is still a vital tool in many communities.

The jurisdictions felt that external partner support was essential. Early partner support provided the necessary resources to prepare most USAPI for the vaccine rollout. However, the need for partner support continued throughout the vaccination campaign. These needs included supplies of vaccines and ancillary kits, technical assistance in risk communication, IIS support, coverage analysis, vaccination administration staff and cold chain logistics. The jurisdictions felt a crucial part of their success was the early and continued support from external partners (primarily led by CDC).

This study has some important limitations to note. For one, we did not evaluate the vaccination coverage rates in populations of focus other than older age, such as health-care workers and individuals with co-morbidities at high risk for severe disease. This prevents us from examining potential challenges in vaccinating these populations, especially since the USAPI have a high burden of non-communicable disease. The coverage data presented for the USAPI and the USA have limitations due to population estimates, which may be inaccurate. The use of whole-population estimates for the USAPI when COVID-19 vaccinations were not yet available in many outer island areas in the USAPI during the study period may have impacted reported coverage estimates, though these populations are generally small. Additionally, the data quality limitations from state-level data may have resulted in inaccurate estimates of vaccine administration. Another limitation of this evaluation is its limited time frame, which only allows us to observe the initial rollouts of the two-dose COVID-19 vaccines Pfizer-BioNTech and Moderna. The time frame does not include the rollout of the one-dose Janssen vaccine, an important feature that would circumvent the steep cost of returning to hard-to-reach outer islands to administer second doses.

The experiences from the USAPI COVID-19 vaccine rollout are essential lessons that can be used to navigate the early stages of future rollouts of COVID-19 and other vaccination initiatives in small island nations around the world, including tailored vaccination strategies building

from pre-existing vaccine preparedness plans, early community education and engagement, adaptive communication plans to rapidly address misinformation and flexible strategies to respond to changes in demand and resource constraints. Maintenance of the jurisdictions' valuable planning preparedness efforts, newly installed infrastructure and local partnerships can strengthen the resilience of the jurisdictions for a range of challenges beyond the COVID-19 response. As vaccination efforts continue in the USAPI, continued programme success will rely on implementing vaccine delivery in the outer island communities and adapting to changes in vaccine demand. As more of the population was vaccinated, the primary challenge shifted from maintaining adequate vaccine supply to encouraging vaccine demand. Future strategies should build from the successful vaccination plans showcased here to face future challenges as the jurisdictions shift towards integrating COVID-19 vaccinations into routine immunisation efforts and maintaining new infrastructure and partnerships established during these campaigns.

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