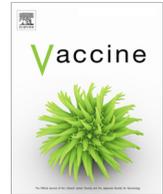




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## Commentary

# COVID-19 vaccinations in Bhutan – Mix-and-Match to Boosters: An experience



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## ABSTRACT

Bhutan – a landlocked least developed country in the Himalayas – vaccinated 94% of its adults with the first dose of COVID-19 vaccine in March–April 2021, 90.2% with second dose in July 2021, and 89.1% with booster (third) dose by March 2022.

The country used COVISHIELD (Oxford–Astrazeneca) vaccine for the first dose but decided to pursue a heterologous prime-boost strategy (“mix-and-match”) for the second dose using Moderna’s mRNA vaccine for adults.

Bhutan rapidly rolled out Pfizer and Moderna vaccines for 12 to 17-year-olds through a school-based vaccination strategy followed by booster doses: 78.6% of adolescents aged 12–17 years were vaccinated with the first dose by August 2021, 92.8% with second dose by November 2021, and 79.7% with booster (third) dose by March 2022. More than 97% of children aged 5 to 11 years have received Pfizer’s Comirnaty vaccine for their first dose.

Bhutan is steadily vaccinating its population and might soon become one of the few least developed countries to achieve herd immunity-level vaccination coverage with more than 80% of its population fully vaccinated.

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## 1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) saw vaccine development at an unprecedented scale and speed. Many of these vaccines have been rolled out in nationwide vaccine campaigns in different countries. As of 26 March 2022, 11.0 billion doses had been administered worldwide [1].

Bhutan – a landlocked least developed country (LLDC) in the eastern Himalayas – has implemented numerous public health measures including mass vaccination of its population to fight COVID-19. Amidst global vaccine inequity and shortages, it advocated heterologous prime-boost (“mix-and-match”) vaccination for adults, swiftly vaccinated its children and adolescents, and is now rolling out booster doses (3rd dose) for adults and adolescents. This paper describes the various strategies adopted by the country in its bid to achieve herd immunity and mitigate the impact of COVID-19.

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## 2. Vaccination of Adults

### 2.1. First dose

Building on its success in childhood vaccination and existing vaccine delivery infrastructure, the country launched a two-week-long nationwide vaccination campaign from 27 March to 9 April 2021 [2]. Nearly 472,000 individuals (94% of all adults) were vaccinated in 1001 vaccination booths across the country [2]. To increase coverage, health personnel made home visits for the disabled and elderly population; others residing in institutions such as monasteries, rehabilitation centres and prisons were vaccinated through similar visits. People who missed the first dose for various reasons continued to receive their first dose from the nearest health facility after the campaign period ended. All individuals received the COVISHIELD vaccine (Oxford–AstraZeneca, ChAd-Ox-1 manufactured by the Serum Institute of India).

### 2.2. Mix-and-match for second dose

Without a vaccine manufacturing unit in the country and with India discontinuing export of COVID-19 vaccines, Bhutan had to

rely on vaccine imports for the second dose. The country received a consignment of vaccines 16 weeks after administering the first dose. This consignment included 500,000 doses of Moderna and 5,850 doses of Pfizer vaccine from the USA through COVAX facility; 350,000 doses of AstraZeneca from Denmark, Croatia, Bulgaria and a few other European countries; and 50,000 doses of Sinopharm donated by the People's Republic of China.

In tandem with the arrival of vaccines in the country, Bhutan's National Immunization Technical Advisory Group (NI-TAG) recommended a heterologous prime-boost (mix-and-match) strategy with an option for homologous vaccination as well using AstraZeneca vaccine.

In order to garner public confidence in the mix-and-match modality, the government led by the Prime Minister and the Health Minister engaged in public awareness and interactive discussion sessions both on mainstream and social media. The Prime Minister along with a group of volunteers (including prominent public figures such as Members of Parliament, foreign diplomats, high level government officials, and other members of public) received the Moderna vaccine as their second dose in a live, televised event on 17 July 2021, three days before the nationwide rollout [3]. (Fig. 1).

### 2.3. Vaccine rollout

The second dose of COVID-19 vaccines was rolled out nationwide on 20 July 2021. Although logistics and infrastructure for vaccine distribution had been well-established and tested during the first dose campaign, heavy monsoon rains causing road blocks and strict temperature requirements to store Moderna vaccine (–6 degrees Celsius) posed new challenges. The Ministry of Health resorted to undersupplying the Moderna vaccine initially to each district: it distributed only 80% of predicted stock with Moderna and the remaining 20% with Astra-Zeneca. This was done to avoid “wastage” of Moderna vaccine in anticipation of individuals choosing homologous booster dose; they planned on sending additional supplies (if required) based on the uptake during the initial few days in each district.

By the end of first week on 26 July 2021, 447,381 individuals (90.2% of adults) received their second dose through 1217 vaccination booths across the country. The vast majority (95%) opted for heterologous vaccination. A total of 4868 health workers and 2161 *De Suung* volunteers were involved in the campaign. From



**Fig. 1.** The Prime Minister of Bhutan, *Lyongchen* (Dr.) Lotay Tshering receiving his second COVID-19 vaccine with Moderna's mRNA vaccine in Thimphu on 17 July 2021, three days ahead of the nationwide vaccine rollout, in order to boost public confidence in the “mix-and-match” strategy advocated by the government (Courtesy: Ministry of Health, Royal Government of Bhutan).

27 July 2021 onwards, health workers and *De Suung* volunteers began home visits for the disabled and elderly as well as institutional vaccinations (prisons, monasteries). Close to 1,100 individuals were vaccinated through home visits. Those who missed the second dose during the week-long vaccination campaign continued receiving their vaccines from the nearest health centres. As of 17 August 2021, 474,447 individuals had received two doses of COVID-19 vaccine.

### 2.4. Booster dose

Following the approval by the Food and Drug Administration (FDA) of United States and the European Medicines Agency (EMA) for booster doses, adults from “priority groups” (elderly older than 65 years, individuals with co-morbidities, health workers, individuals traveling abroad and residents of ‘high risk areas’) received their first booster dose (3rd dose) between 24 and 31 December 2021. NI-TAG recommended providing mRNA vaccines (Pfizer or Moderna) for the booster doses for people who received heterologous vaccination. By 1 January 2022, nearly 170,000 individuals (93% of priority group) had received their booster dose.

After securing more vaccines, the rest of the adult population received their first booster dose from 24 January 2022 onwards. In areas under lockdown, the booster dose was facilitated through Mobile Vaccination Teams (MVTs) that went to each locality in full personal protective equipment (PPE) to vaccinate residents. As of 1 March 2022, 89.1% of all adults had received their booster dose.

## 3. Vaccination of children

### 3.1. Children aged 12 to 17 years

Realizing the importance of vaccinating children to achieve overall herd immunity, Bhutan adopted a staggered vaccination strategy for its children. Prior to 23 July 2021 when Pfizer-BioNTech's BNT162b2 was the only vaccine approved for emergency use for children under 18 years, the government used its leftover stock of 5,850 doses from adult vaccine campaign for schoolchildren of two towns with active COVID-19 outbreaks at the time – Phuentshogling and Samtse.

After the EMA granted approval for Moderna vaccine for children aged 12–17 years, the Ministry of Health vaccinated 38,000 children of nine districts (Chhukha, Dagana, Paro, Pema Gatshel, Samdrup Jongkhar, Samtse, Sarpang, Thimphu and Zhemgang) with highest COVID-19 cases between 29 July – 2 August 2021 [4]. Another 12,000 schoolchildren in four other districts (Haa, Trashigang, Trashigang and Tsirang) were vaccinated with the first dose from the leftover vaccine from 12 August 2021 [5]. By 31 August 2021, 78.6% of 12- to 17-year-olds had received their first dose [6].

In early September 2021, following the arrival of 198,000 doses of Pfizer-BioNTech vaccines, adolescents in the remaining seven districts received their first dose and those vaccinated earlier received their second dose [7]. By November 2021, 92.8% of the adolescents aged 12–17 years had received two doses of COVID-19 vaccine.

Between 12 and 18 March 2022, they received their booster (third) dose through both school-based and nationwide vaccine campaign, with a coverage of 79.7% as of 23 March 2022.

### 3.2. Children aged 5 to 11 years

The US FDA and EMA authorized Pfizer-BioNTech's Comirnaty mRNA vaccine for use in children aged 5 to 11 years in October



**Fig. 2.** The Bhutan Vaccine System (<https://bvs.moh.gov.bt/>). (a) The portal's home screen showing various menu bars to register for vaccine, view vaccine record/certificate and for self-reporting adverse event following immunization; (b) Sample COVID-19 vaccine record/certificate generated (Courtesy: Bhutan Vaccine System portal and Ministry of Health, Royal Government of Bhutan).

and December 2021, respectively. Bhutan vaccinated 81,000 children (97.25% of target population) with the first dose in this age group between 6 and 12 March 2022 through a week-long vaccination campaign. The Health Ministry once again conducted widespread public awareness media campaigns before the vaccine rollout: NI-TAG members gave television interviews, the Ministry published infographics containing frequently asked questions and the Health Minister gave a televised interview while vaccinating her own child. The children are scheduled to receive their second dose from 4 April 2022 onwards.

#### 4. Impact and way forward

There are no studies to directly estimate the number of infections and/or deaths prevented from vaccination in Bhutan. As of 8 April 2022, Bhutan reported 38,921 cases with 13 deaths (case fatality ratio, CFR = 0.03%). Majority of cases reported are either asymptomatic or with mild/moderate symptoms being managed at home/hotels. It is also noteworthy that each surge in cases – Delta variant in May-June 2021 and Omicron variant from February 2022 till date – were preceded by nationwide vaccinations: first dose and adult booster/pediatric first dose, respectively. Public health measures combined with high vaccination rates probably contributed in averting a total collapse of the Bhutanese health system.

##### 4.1. Bhutan vaccine system

The Bhutan Vaccine System (BVS) was developed by the Ministry of Health specifically for COVID-19 vaccination. It serves as a vaccine registration portal for users, as a recording system

for healthcare providers (date and place of vaccine, vaccine brand including manufacturer lot number, any adverse event following immunization (AEFI), etc) and to generate a vaccine certificate (Fig. 2). The BVS has served as a useful and efficient vaccine record system which has facilitated real-time monitoring and recording COVID-19 vaccine status of the entire population.

##### 4.2. Global travel

As COVID-19 vaccination picks up globally, several nations have started implementing either some form of “vaccine passport” system with waivers or concessions on travel, quarantine and/or) testing for fully vaccinated individuals, or created “vaccine corridors” with entire nations put on travel lists based on COVID-19 outbreak statuses and/or) population vaccination levels. Such practices highlight the growing vaccine inequity worldwide. Poorer, underdeveloped nations have vaccinated less than five percent of their population [9] while developed countries have surplus stock approaching expiry dates [10].

Although an LLDC, Bhutan has managed to achieve remarkable COVID-19 vaccine coverage approaching herd immunity levels. This may facilitate Bhutanese travelling abroad as well as allowing it to open its borders. The government is progressively shortening the duration of mandatory quarantine for fully vaccinated individuals entering the country: 14 days (instead of 21 days) between 30 August 2021 to 3 April 2022, and five days from 4 April 2022 onwards. The first tourist since the closure of international borders arrived in the country in August 2021 [11]. A second batch of 32 tourists arrived in the country on 2 April 2022. Bhutan has operated several flights under its maiden air travel bubble agreement with India since September 2020 [12].

### 4.3. Global humanitarian corridor during pandemics

Despite numerous vaccine candidates available and vaccine production being upscaled, it is estimated that only 1% of population in low- and middle-income countries have received one dose of COVID-19 vaccine [13]. The problem has been aggravated with political embargo on export of both vaccine and vaccine technology/ingredients.

During pandemics and global health emergencies, the underdeveloped and developing countries suffer disproportionately as their scarce resources are stretched in fighting such emergencies. This exposes the most vulnerable population – women, children and the poor – to other infectious diseases and malnutrition while the poorly-equipped health systems either collapse entirely or are unable to continue routine, essential health services. At the World Health Assembly in May 2021, Bhutan proposed the need for “global humanitarian corridor” that enables uninterrupted flow of critical medical supplies including essential medicines and vaccines during pandemics [14]. The World Health Organization needs to establish such humanitarian corridors in order to ensure that the most vulnerable nations and people continue receiving essential primary healthcare even during times of health emergency. Since Bhutan received a surplus of Astra-Zeneca vaccines while it used Moderna for the second dose, the country donated 130,000 doses of Astra-Zeneca vaccines to Nepal and “loaned” 150,000 doses of Astra-Zeneca to Thailand [8].

## 5. Conclusion

Bhutan has administered three doses of COVID-19 vaccine to nearly 90% of adults and 80% of adolescents, and vaccinated 97% of children aged 5–11 years with the first dose. The country managed to overcome vaccine supply issues through diplomatic engagements and systematic planning and administration of COVID-19 vaccines to achieve herd immunity.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Contributors

Both authors conceived the idea, were involved in critical review of the article and have approved the final draft for publication. STT drafted the article.

## Research ethics approval

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