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Modeling the Potential Public Health Impact and Cost-effectiveness of BNT162b2 COVID-19 Booster Vaccination in the Dominican Republic

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INTRODUCTION

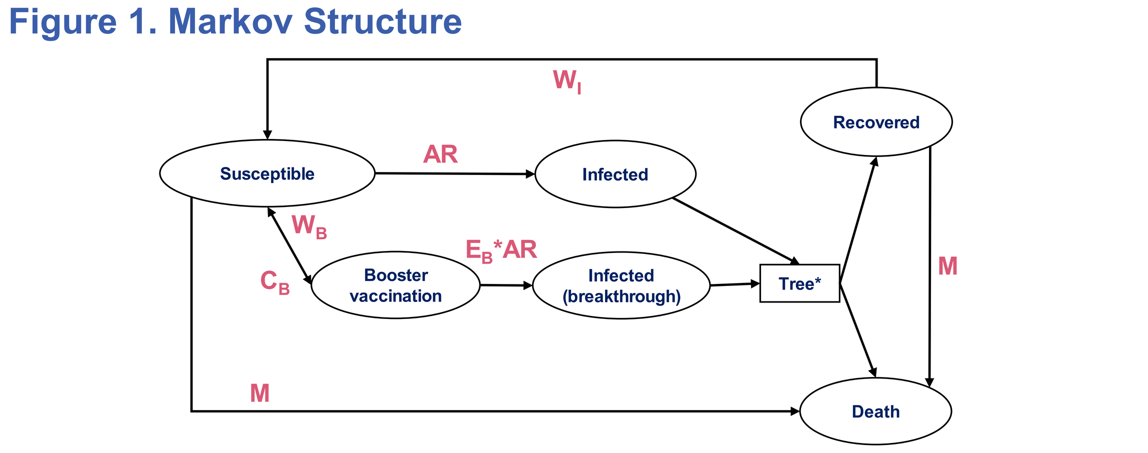
- COVID-19, caused by the SARS-CoV-2 virus, has resulted in about 777 million confirmed cases and 7 million confirmed deaths globally. In the Dominican Republic, 661,000 cases and 4,400 deaths were reported as of December 21, 2024.[1]
- Although COVID-19 has become endemic, it still continues to circulate in Latin America and the Caribbean[2] and imposes considerable economic costs on the national healthcare system in the Dominican Republic.[3]
- By December 2023, the Dominican Republic had administered 16.43 million doses of COVID-19 vaccine, vaccinating 61% of its population with the complete primary COVID-19 vaccination series and 22.9% with at least one booster dose.[4] Given the decay of the COVID-19 vaccine effectiveness over time,[5,6] additional vaccinations have become essential. Furthermore, SARS-CoV-2 has been evolving into new variants, including BA.2.86 and JN.1 identified by June 2024, which may respond to existing COVID-19 vaccines with a lower efficacy.[7]
- Technical advice and guidance on the formulation of COVID-19 vaccines has been offered by the WHO's Technical Advisory Group on COVID-19 Vaccine Composition. Their recommendations for vaccine formulations included a monovalent XBB.1 descendent lineage in May 2023 and a monovalent JN.1 lineage in April 2024.[8] In the Dominican Republic, BNT162b2 COVID-19 (COMIRNATY) received regulatory approval in April 2024 for the XBB.1.5 lineage, and the COMIRNATY JN.1 vaccine was approved in February 2025.
- This modeling study evaluated the economic and health implications of vaccination with an adapted vaccine in the Dominican Republic.
- This modeling study evaluated the economic and health impacts of administering BNT162b2 COVID-19 annually with an adapted[a] COVID-19-booster vaccine[9] from both a public payer and societal perspective in the Dominican Republic.

[a]*The BNT162b vaccine initially included mRNA from the original SARS-CoV-2 virus. As new variants with different proteins have emerged, BioNTech and Pfizer have developed updated versions of the BNT162b vaccine that incorporate mRNA from specific variants, referred to as variant-adapted COVID-19 mRNA vaccines. Updated vaccines may include variant mRNA along with or instead of the original virus mRNA.*[9]

METHODS

- An established integrated Markov cohort decision tree model[10] was modified to fit the Dominican Republic setting in order to evaluate the economic and health implications of a booster vaccination strategy using an adapted vaccine. The study focused on multiple age groups over a 1-year time horizon, examining an adjusted eligible population (n=1,157,891) of individuals aged ≥65 years as well as high-risk individuals aged 18–64 years in the base case.
- Using a Susceptible-Infected-Recovered structure, the Markov component of the model (**Figure 1**) tracked the target population through distinct health states. Concurrently, the decision tree component modeled disease severity, treatment pathways (e.g., outpatient, inpatient, ICU), and associated outcomes (**Figure 2**).

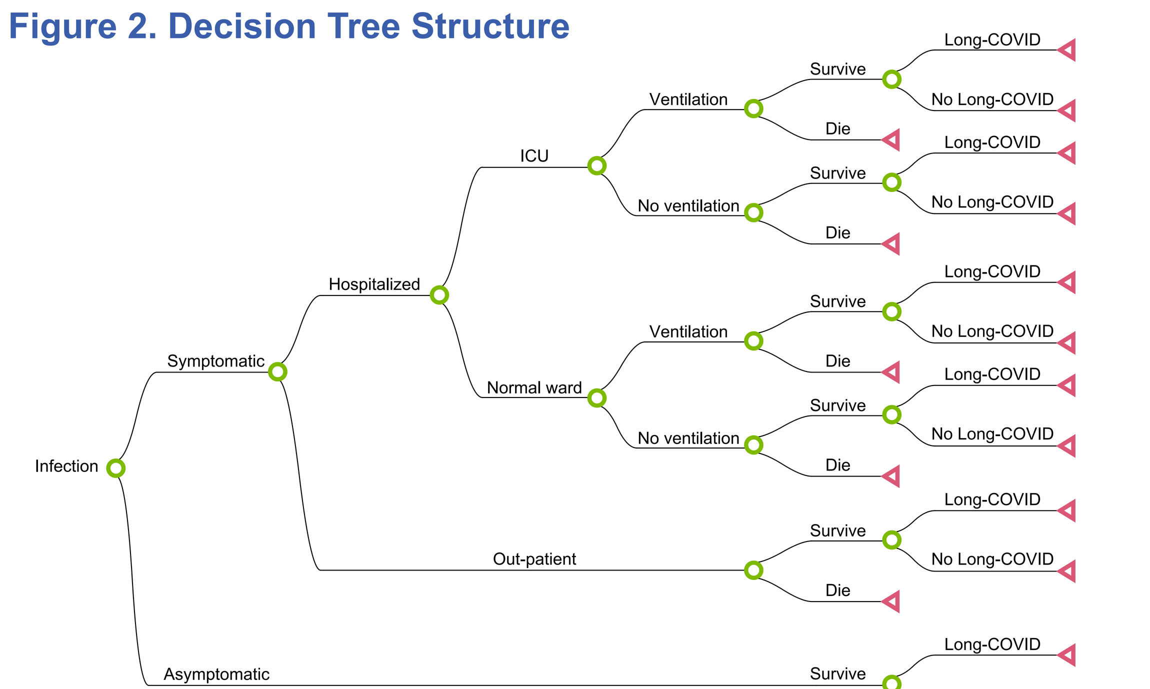
Figure 1. Markov Structure



W_B: waning post booster; AR: attack rate; E_B: efficacy post booster; W_I: waning of infection-induced immunity; C_B: booster coverage; M: background mortality

*From each infected state patients will transition to a decision tree each with the same structure but different probabilities

Figure 2. Decision Tree Structure



Abbreviations: ICU = intensive care unit

METHODS (cont.)

Inputs

- Epidemiological model inputs were obtained from the Dominican Republic Ministry of Health or from published literature (**Table 1**). When local data were unavailable, information from the health ministries of similar countries was used.
- Real-world evidence[11-18] was used to define the vaccine profile in the model, with effectiveness rates of 50% for preventing infections, 60% for preventing symptomatic infections, and 70% for preventing hospitalization. The duration of vaccine protection was set at 6 months. It was assumed that immunity from infection lasts for 3 months.
- This economic model considered the probability of complications in the high-risk population by using risk ratios for increased hospitalization, severe COVID-19 requiring ICU care, and mortality.[19]
- Inpatient and outpatient treatment costs, as well as the length of stay for inpatient treatment, were sourced from a local study.[3] Long COVID treatment inputs were based on the assumptions of four COVID-19 tests, four general practitioner visits, one specialist visit, and a 17% probability of hospitalization.[20] Vaccine acquisition costs per dose were obtained from the Pan American Health Organization´s revolving fund.[21]
- Indirect costs related to productivity losses due to COVID-19 and long COVID were estimated from a societal perspective. Workforce participation rates were estimated using data from the Dominican Republic Central Bank.[22,23] Weekly labor costs were estimated using salary data by years of experience from Mexico[24] and the average salary in the Dominican Republic, as provided by the country's statistics bureau.[25]
- QALY inputs were sourced from the literature.[26-32]
- This study used a 3% discount rate for costs and health effects.[27]
- All costs were either expressed in 2024 USD or inflated to 2024 USD

Table 1. Epidemiology and Clinical Inputs

Input Description	18–29 Years	30–49 Years	50–64 Years	65–74 Years	≥75 Years	References
Population size (thousands)	2,157	2,885	1,466	563	332	Dominican Republic Statistics Bureau[33,34]
Proportion at high risk	33.10%	40.50%	67.77%	75.20%	75.20%	Clark et al.[35]
Annual attack rate	7.67%	5.25%	9.93%	18.83%	18.10%	Nilles et. al[36] Boletín Epidemiológico[37] Underreporting factor (146.3) derived from Colombia as a proxy (Mustapha et al.[38]) was applied.
Probability that infection is symptomatic	67.90%	67.90%	67.90%	80.30%	80.30%	Sah et al.[39]
Proportion of symptomatic patients (medically attended) who are hospitalized	0.08%	0.14%	0.38%	0.68%	1.21%	Costa Rica Ministry of Health[40,41] (due to lack of data)
Proportion of hospitalized patients admitted to ICU	0.17%	0.20%	0.28%	0.42%	0.42%	Ascencio-Montiel et al.[19] Costa Rica Ministry of Health[40]
Proportion of ICU patients on mechanical ventilation	71%	71%	71%	71%	71%	Augustovski et al.[27]
Probability of death among patients on normal ward without ventilation	0.16%	1.26%	2.70%	2.20%	3.87%	Costa Rica Ministry of Health[40,41] (due to lack of data)
Probability of long COVID – *Vaccinated*	12.32%	14.62%	14.55%	13.86%	15.47%	Angarita-Fonseca et al.[20]
Probability of long COVID – *Susceptible*	16.42%	19.50%	19.40%	18.48%	20.63%	

Abbreviation: ICU = intensive care unit

RESULTS

- Compared with no vaccination, the vaccination strategy targeting adults aged ≥65 years and high-risk individuals aged 18–64 years was projected to avert 8,058 symptomatic cases, 7,982 outpatient cases, 76 hospitalizations, 208 lost QALYs, and two deaths. This resulted in an incremental direct cost reduction of USD 9,499,720 and total societal cost savings of USD 10,896,472 (**Table 2**).
- Compared with no vaccination, vaccinating individuals aged ≥60 years and high-risk individuals aged 18–59 years averted 9,532 symptomatic cases, 9,450 outpatient cases, 82 hospitalizations, 249 lost QALYs, and two deaths. In addition, this alternative vaccination strategy resulted in an incremental direct cost reduction of USD 10,435,103 and total societal cost savings of USD 12,198,060 (**Table 2**).
- From both the payer and societal perspective, the strategy is considered dominant because it results in improved health outcomes at a lower cost.
- In deterministic sensitivity analysis (considering a 10% variation for the lower and upper bound values of the base case), cost results were driven mostly by the cost of outpatient visit, the duration of protection of the vaccine, and attack rates of older populations. QALY results were impacted by the duration of protection of the vaccine, attack rates of older populations, and utility decrements (**Figure 3** and **Figure 4**).
- In probabilistic sensitivity analysis, 100% of iterations using the payer perspective were below the willingness-to-pay threshold of gross domestic product per capita (**Figure 5**).

RESULTS (cont.)

Table 2. Results of COVID-19 Vaccine vs. No Vaccination

		Aged ≥65 Years and High-risk Individuals Aged 18–64 Years		Aged ≥60 Years and High-risk Individuals Aged 18–59 Years	
Outcome	**No Vaccination**	**COVID-19 Vaccination**	**Incremental Difference**	**COVID-19 Vaccination**	**Incremental Difference**
Total population	10,702,527	10,702,527	0	10,702,527	0
Doses administered	0	246,728	246,728	329,326	329,326
Health outcomes					
Symptomatic cases	454,820	446,762	-8,058	445,287	-9,532
COVID-19-related deaths	47	45	-2	45	-2
Outpatient cases	453,028	445,046	-7,982	443,578	-9,450
Hospitalizations	1,792	1,716	-76	1,710	-82
Discounted QALYs lost	10,361	10,153	-208	10,112	-249
Economic outcomes					
Vaccine acquisition	–	$4,441,105	$4,441,105	$5,927,860	$5,927,860
Vaccine administration	–	$1,038,725	$1,038,725	$1,386,461	$1,386,461
AE management cost	–	$94,270	$94,270	$125,829	$125,829
Long COVID treatment costs	$87,969,506	$86,449,435	-$1,520,071	$86,124,003	-$1,845,503
Inpatient treatment cost	$3,874,108	$3,707,523	-$166,585	$3,693,618	-$180,490
Outpatient treatment cost	$759,782,687	$746,395,522	-$13,387,165	$743,933,427	-$15,849,260
Total direct cost	**$851,626,300**	**$842,126,580**	**-$9,499,720**	**$841,191,197**	**-$10,435,103**
Discounted productivity loss	$68,260,665	$66,863,912	-$1,396,752	$66,497,708	-$1,762,957
Total societal cost	**$919,886,965**	**$908,990,493**	**-$10,896,472**	**$907,688,905**	**-$12,198,060**
ICER – Payer (USD/QALY)*	–	–	**Dominant**	–	**Dominant**
ICER – Societal (USD/QALY)*	–	–	**Dominant**	–	**Dominant**

Abbreviations: AE = adverse event; GDP = gross domestic product; ICER = incremental cost-effectiveness ratio; QALY = quality-adjusted life year; USD = US dollar
*Cost-effectiveness threshold was defined as 1x GDP per capita (USD 11,690) in 2024.[42]
Costs are expressed in 2024 US dollars.

Figure 3. Deterministic Sensitivity Analysis: Incremental Costs (Millions –USD)

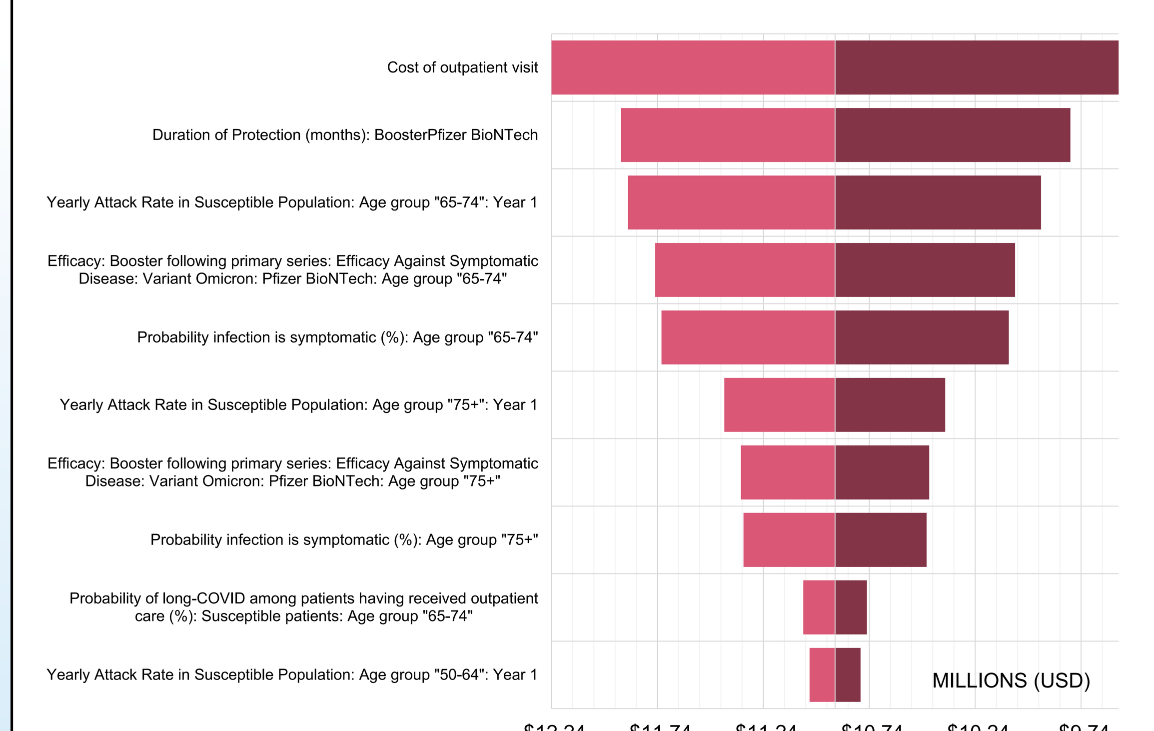
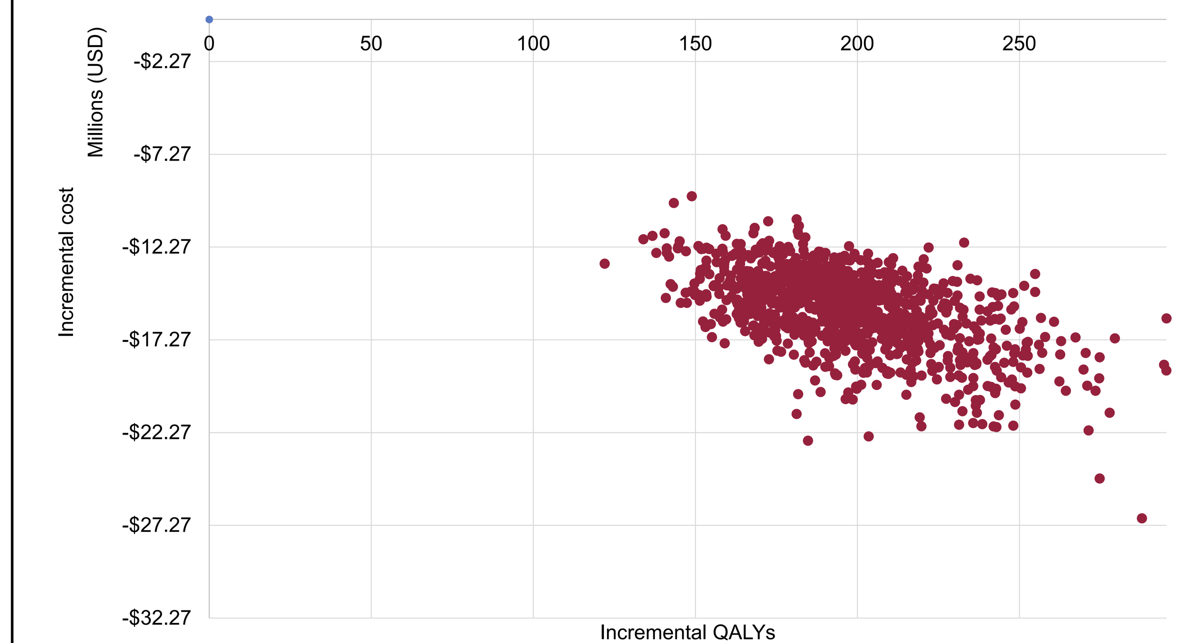


Figure 4. Deterministic Sensitivity Analysis: Incremental QALYs

Abbreviation: QALY = quality-adjusted life year

RESULTS (cont.)

Figure 5. Probabilistic Sensitivity Analysis



Abbreviations: QALY = quality-adjusted life year

CONCLUSIONS

- **A vaccination strategy targeting individuals aged ≥65 years and high-risk individuals aged 18–64 years led to significant public health and economic benefits in the Dominican Republic. This strategy was dominant from both a societal perspective and a payer perspective. Expanding the strategy to include adults aged ≥60 years and high-risk individuals aged 18–59 years further enhanced these benefits.**

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Disclosures

This study was sponsored by Pfizer Inc. JJBC, CFM, MHK, IC, LB, MML, and KVH are employees of and may hold shares in Pfizer. EA and BY are employees of PPD™ Evidera™ Health Economics & Market Access, Thermo Fisher Scientific, which was contracted by Pfizer to conduct this study.

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