Public health and budget impact analyses of implementing a 23valent pneumococcal polysaccharide vaccine in the Brazilian national immunization program for a cohort of 60-year-old adults

Background

- Vaccine-preventable pneumococcal diseases are associated with substantial levels of hospitalization, morbidity, and mortality in older adults, resulting in significant clinical and economic burden^{1,2}
- Universal vaccination in older adults has emerged as public health priority worldwide, including some countries in Latin America³
- Brazil does not include pneumococcal vaccination as part of the older adults' immunization schedule in the National Immunization Program (NIP). It is currently offered to institutionalized elderly and persons aged ≥2 years with chronic conditions since 1999 in few public immunization centers across the country.³ Vaccination coverage data in this population is scarce⁴
- the national local HTA agency (CONITEC), requesting the incorporation of new technologies⁵

Objective

• To estimate the public health and budget impact of implementing a single-dose of 23-valent pneumococcal polysaccharide vaccine (PPSV23) into NIP for one cohort of adults aged 60 years from the Brazilian public payer perspective (Brazilian Public Unified Health System - SUS) perspective

Methods

- An Excel-based cohort budget impact model with a 5-year time horizon (2022-2026) was adapted for Brazil (Figure 1) ^{6,7}
- Budget impact was calculated by comparing no vaccination (baseline scenario) to PPSV23 implementation in NIP at varying vaccination coverage rates of 50%, 70%, and 100% (scenarios A, B, and C, respectively). As the initial cohort aged, new populations were added to the target age cohort and costs/disease cases were calculated cumulatively
- Perspective: Public payer (SUS)
- ✓ Time horizon: 5 years
- ✓ Cycle length: 1 year
- ✓ Data source: retrieved from Brazilian sources; international literature was used where not available (Table 1 and 2)
- \checkmark **Population distribution:** healthy (58%), at-risk (32%), and high-risk (10%) subgroups⁷⁻⁹
- ✓ Vaccination coverage: 50% (scenario A), 70% (scenario B), and 100% (scenario C) Market share: 100% PPSV23
- ✓ Serotype distribution: PPSV23 covered 61.2% of all IPD and NBPP cases in adults aged >60 years¹¹
- ✓ **PPSV23 vaccine effectiveness/ waning function:** 73% for IPD and 33.5% for NBPP with a linear 9-year waning¹²

Costs	US\$
Acquisition costs	
Unit price of PPSV23 ¹⁵	8.63
Administration costs ¹⁶	1.90
Medical costs (per episode)	
IPD ¹	642
Meningitis ¹	711
Managing post-meningitis sequelae912	912
NBPP (inpatient) ¹	225
NBPP (outpatient) ¹⁷	20

Table 1. Cost parameters

Currency exchange: 2021 US\$ 1 = R\$ 5.14



IPD, invasive pneumococcal disease; NBPP, non-bacteremic pneumococcal pneumonia; PMS, post-meningitis sequelae.

Figure 1. Markov model structure

- Five health states were considered in the model structure:no pneumococcal disease, IPD, NBPP, post-meningitis sequelae (PMS) and death
- Vaccinated or unvaccinated individuals entered the model with no pneumococcal disease, and they risked developing IPD or NBPP
- Patients with IPD or NBPP faced higher risk of death than those without pneumococcal disease. Those who survived and recovered then returned to no pneumococcal disease health state, and a proportion of patients who had meningitis may develop PMS.

Pneumococcal disease			
IPD	Incidence per 100,000		
Healthy individuals 18	3		
At-risk individuals ^{8, 9, 19}	59		
High-risk individuals ^{8,9,19}	26		
NBPP			
Healthy individuals 8,9,19	56		
At-risk individuals ^{8, 9, 19}	544		
High-risk individuals ^{8,9,19}	191		
IPD	Percentage		
Case-fatality rate (%) ^{1a}	43.8		
Meningitis proportion ^{20a}	14.1		
PMS ^{21a}	31.7		
NRPP			
Case-fatality rate (%) ^{1b}	12.2		
Hospitalization rate (%) 23b	42		

 Table 2. Epidemiological parameters

^aUsed the same proportion for healthy, at risk, and high-risk populations. ^bThe estimate of S pneumoniae proportion was 20.5%.24

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Results

- Compared to no vaccination, vaccinating one cohort of 60-year-old with PPV23 was estimate to avoid between 7,124 to 14,248 cases of IPD and NBPP and between 544 to 1,087 deaths over 5-years, respectively (Table 3)
- For a cohort of about 2.1 million 60 years-old, the direct costs for treatment of disease in the current scenario with no vaccination is \$8 million over a 5-year time horizon (Table 4)
- As a result of the preventing pneumococcal diseases, the cost of vaccination was increasingly offset by direct medical costs for invasive and noninvasive diseases from 2022 to 2026 (Table 4)
- Between 2022 and 2026, vaccinating one cohort of 60-years old with PPV23 was predicted to cost the national healthcare system between 56 million (scenario A) and 112 million (scenario C), when compared to no vaccination (Table 4)

Table 3. Total of cases avoided with the PPSV 23 implementation at varying vaccination coverage rates from 2022-2026

Outcomes	VCR 50%	VCR 70%	VCR 100%
IPD cases	464	650	929
NBPP cases	6,660	9,324	13,319
PMS cases	21	29	42
IPD and NBPP deaths	544	761	1,087

Table 4. Budget impact analyses at varying vaccination coverage rates

	2022	2023	2024	2025	2026	Total
No vaccination						
Direct medical costs	309,767	936,449	1,575,434	2,223,569	2,879,669	7,924,888
Scenario A - VCR 50%						
Vaccine costs	9,540,203	9,859,913	10,127,782	10,369,759	10,621,305	50,518,962
Administration costs	1,251,106	1,293,032	1,328,161	1,359,984	1,392,882	6,625,074
Direct Medical costs	-39,904	-116,678	-187,079	-250,647	-307,233	-901,541
Total budget impact	10,753,144	11,041,355	11,277,021	11,489,936	11,720,352	56,281,808
Scenario B - VCR 70%						
Vaccine costs	13,356,284	13,803,879	14,178,895	14,517,663	14,869,826	70,726,547
Administration costs	1,751,548	1,810,245	1.859.425	1,859,425	1.950.034	9,275,104
Direct Medical costs	-55,866	-163,34	-261,910	-261,910	-430,126	-1,262,157
Total budget impact	15,054,402	15,457,897	15,787,830	15,787,830	16,408,492	78,794,531
Scenario C- VCR 100%						
Vaccine costs	19,080,406	19,719,826	20,255,564	20,739,519	21,242,609	101,037,925
Administration costs	2,502,211	2,586,065	2,656,322	2,719,788	2,785,763	13,250,149
Direct Medical costs	-79,809	-233,355	-374,157	-501,295	-614,466	-1,803,082
Total budget impact	21,506,288	22,082,710	22,554,043	22,979,871	23,440,703	112,563,616

Limitations and Discussion

• The Brazilian budget impact analysis guidelines recommend using a high adoption rate in the first year and second year, corresponding to a minimum period of stabilization of the embedded technology and based on historical data from similar technologies⁵

• We used influenza VCR proxy in Brazil, which is estimated in 100%. However, the data obtained from official Brazilian sources was estimated using administrative method, which is calculated by dividing the aggregated number of doses administered annually by the target population using the last census (2010) among older adults. However, the VCR would be around 70% if it the denominator uses population projections¹⁰

• Then, the scenario with 100% VCR probably does not match the real scenario. Several factors related to implementation strategy should be taken in account to estimate potential VCR in a national immunization program such as concomitant administration with other vaccines such as influenza/ COVID-19 vaccines, disease awareness campaigns for the target population and family members, and optimal access of vulnerable subpopulations (e.g., homes for the aged) to the health system

• Since VCR depends on the factors previously described, we used 3 different VCR scenarios for PPSV23. Moreover, we may infer that around 15% of population over 60 years of age has been vaccinated with PPSV23 in any point of their life; assuming 42% in this age group is eligible for vaccination as subgroups at risk or high-risk with an estimate VCR of 30% in public reference centers (12% VCR) and 80% of the total doses marketed in private immunization centers are administered in this age-group (3% VCR)^{8,9,25}

• The budget impact analysis considered the costs with the acquisition and administration of vaccines, not considering the additional costs with transport, storage, hours worked by the health professional to apply the vaccine in primary Health Care, costs of treating the effects adverse effects, if any, and vaccine wastage

Conclusions

- Between 2022 and 2026, when compared to no vaccination, implementing PPV23 was predicted to avoid 7,124 to 14,248 pneumococcal disease cases with a net budget impact between US\$ 56 million and US\$ 112 million
- Given the 100% PPSV-23 defined market share, a larger budget impact is not expected than the one presented in scenario C. Therefore, depending on the implementation strategy, budget impact can be much lower (scenarios A and B) than the one projected in scenario C.

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